MECHANICAL TECHNOLOGY

CATALOG No 205

BUFFALO FORGE CO.

BUFFALO, N. Y. U. S. A.

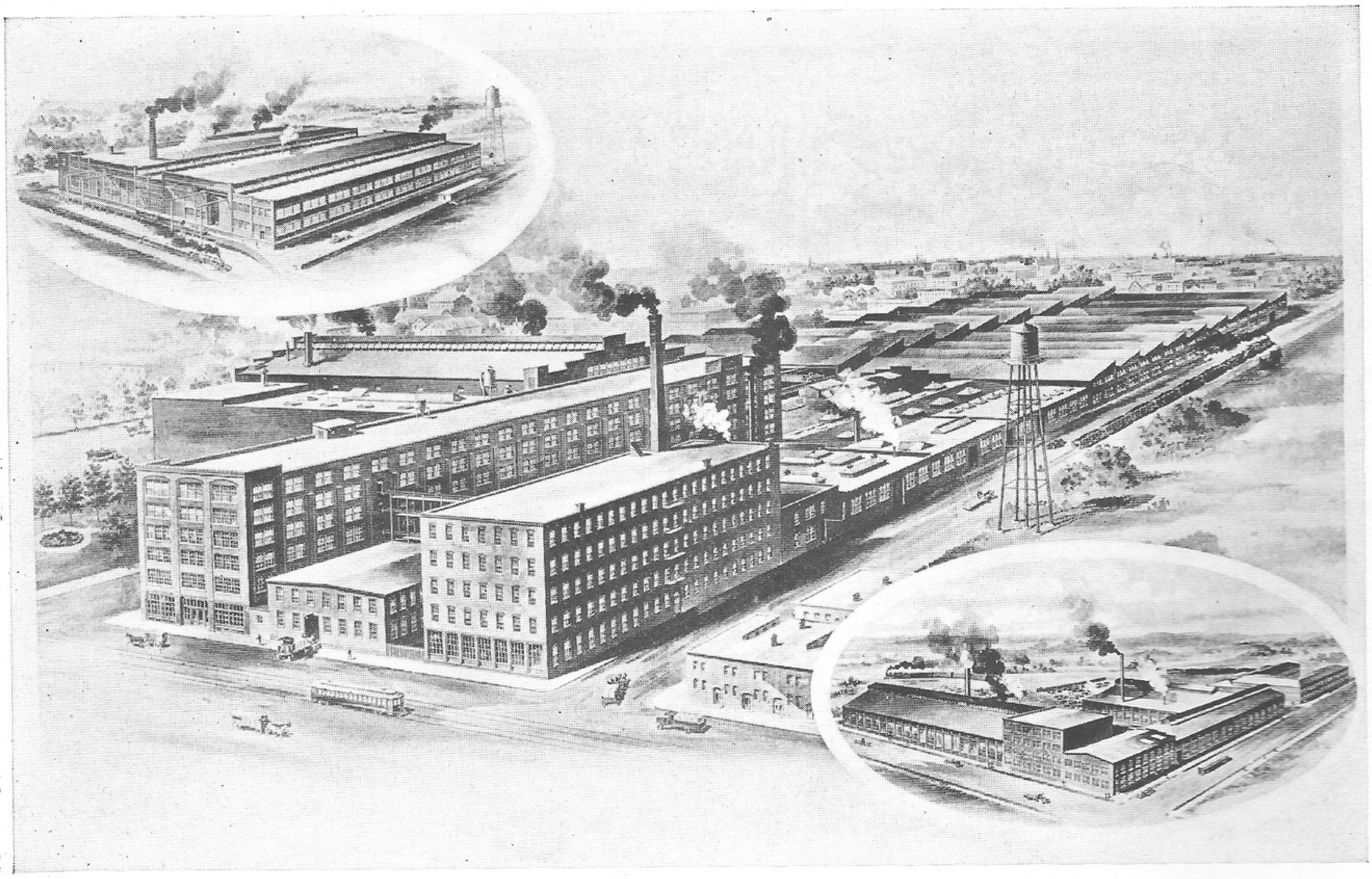
Modern Equipment

for

Schools *of* Mechanical Technology

Buffalo Forge Company

Buffalo, N. Y., U. S. A.



MANUFACTURING PLANT OF THE BUFFALO FORGE COMPANY

Acknowledgment

To the Taylor-Holden Co. of Springfield, Mass., we are indebted for the "Notes on Welding," "Steel," and "Forge Shop Practice."

In the preparation of the tables and schedules in "Exercises in Forge Shop Practice," we have been very substantially assisted by Prof. L. E. Nollau of Kentucky State University, Prof. James Littlefield of the Cleveland Technical High School and Mr. Robert M. Smith, Supervisor of Technical Work in the High Schools of Chicago.

FOREWORD

BEING the inventors and sole manufacturers of the Down-Draft Forge covering a period of 18 years, Buffalo apparatus is installed in practically all of the Manual Training Schools and Technical Institutions in the country, and is considered the standard.

As this branch of training is being given more attention than ever before, we have devoted this book solely to the subject of selecting, installing and operating the Buffalo Forge Shop Equipment in Technical Institutions. We are now offering everything necessary to equip the forge room complete, and the typical layouts with photographs of installation will enable the proposed user to determine the number of forges possible to install in any space available. When an installation is contemplated, it is advisable to send us a sketch showing the dimensions of the forge room, state the number of forges desired, and indicate on sketch the preferred location of same. Upon receipt of such information our Engineering Department will prepare a drawing showing the space required, the best arrangement of the underground ducts for supplying the blast and removing the smoke and gases, and we will prepare complete specifications covering the entire equipment.

In addition to the O2D Forge, which has been standard for Manual Training and Technical Schools for many years, we have developed the OJD Forge which is the last word in forgedom. They are built single and double, the general design being the same. Double forges are recommended where economy in floor space is necessary.

Owing to the increased use of electricity during the past few years, it is now available in most instances, in which case direct-connected motor-driven fans are recommended. They require much less space, less attention, eliminate belt trouble entirely, and require some less power due to the absence of belt losses.

The line of Armor Plate Punches and Shears has proven most popular, and no up-to-date Forge Shop should be without them. Hand operated machines are usually installed, although these can be arranged for power when preferred.

For the convenience of the Instructor we give a set of exercises consisting of 20 plates intended to cover a year's course of work.

Particular attention is called to the Buffalo Woodworker, combining many separate machines, which in total would be much more expensive.

BUFFALO FORGE COMPANY

Typical Installation of Buffalo Down-Draft Forges

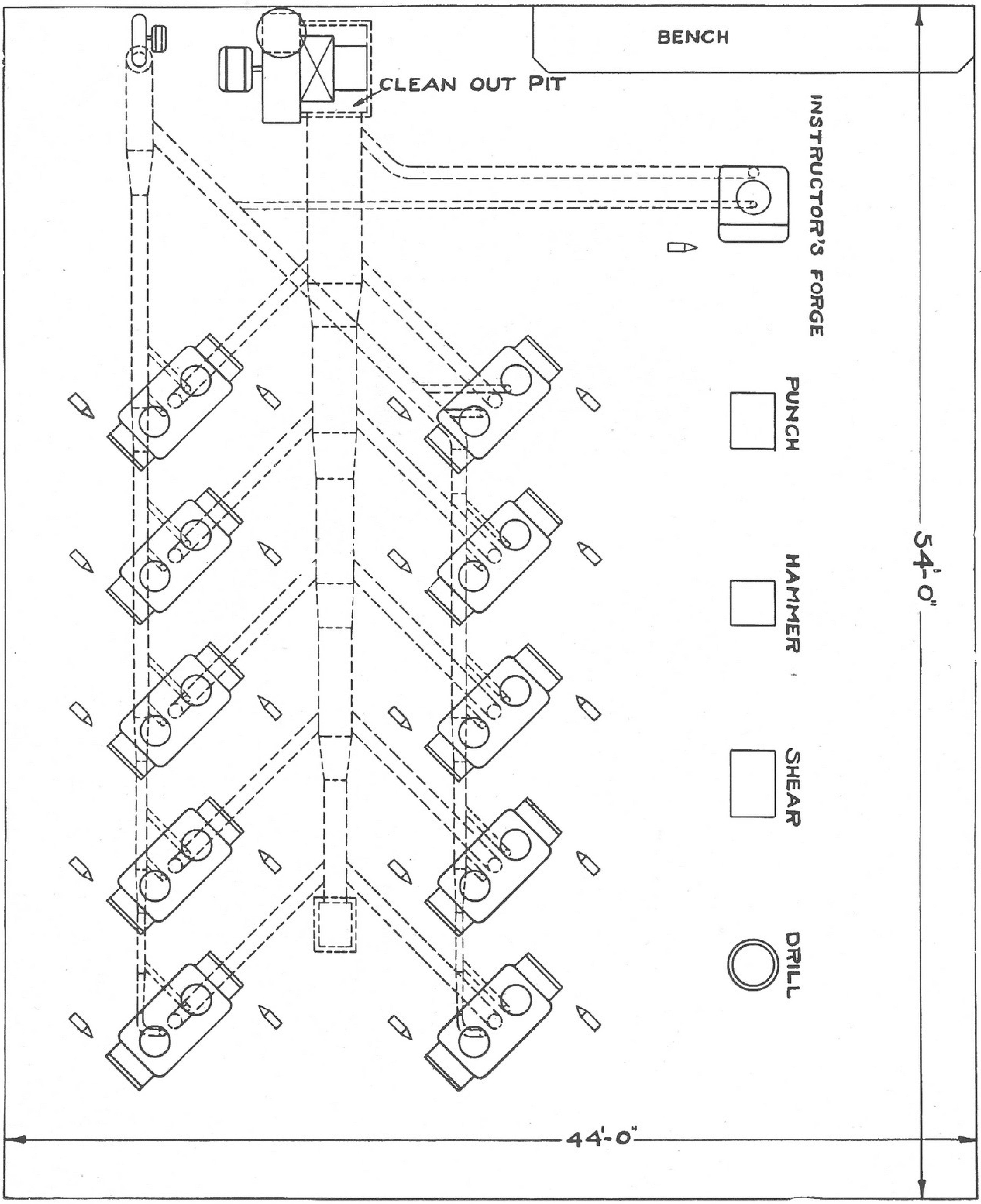
THE layout on opposite page shows a good arrangement of OJD Buffalo Forges set in pairs, back to back. This is the arrangement recommended where floor space is limited. All blast and exhaust piping is placed below the floor line, and is usually constructed of tiling, but a number of recent installations have been made using galvanized iron piping laid in concrete. The piping will rust away within a few seasons, but the concrete ducts remain indefinitely. By placing the ducts below the floor line they are entirely out of the way, offer no obstructions to light, do not overheat the shop during the summer months, and when once installed are practically indestructible, while the overhead system has to be renewed from time to time.

This layout shows both fans direct connected to individual motors, and wherever electricity is available direct-connected fans are recommended, as they do away with the necessity of belting, line shafting, etc., require considerable less space than belted outfits, are somewhat more economical due to no belt losses, and require a great deal less attention. Where sufficient space is available it is advisable to place the fans on or near the floor line, but further economy in floor space is possible by placing the fans on a platform having the blower discharge downward to the underground system, and the exhaust fan vertically into a stack extending through the roof or to a conveniently located chimney.

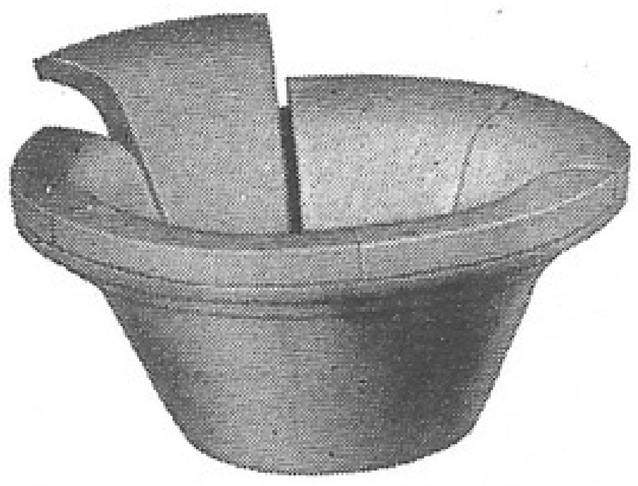
This layout is intended to give the prospective user an idea of the space required for a certain number of forges, and the usual equipment. In addition to the 20 forges for the students, and the instructor's forge, we show a hand-operated punch and shear, a power hammer, and a drill, all of which we are in position to supply.

The Down-Draft System has so many advantages over the ordinary forges with overhead canopy hood that the latter is practically unknown in the modern Training School. The Buffalo Down-Draft System, in addition to effectually removing all smoke and gases from the forge room before they are allowed to pass to all parts of the building, affords excellent ventilation to the entire room, since about 500 cu. ft. of air per minute is removed from the room through each of the down-draft hoods. Wherever telescopic hoods with the overhead piping are used, or down-draft forges with hoods of an inefficient type are installed, large quantities of smoke, soot and gases cannot be avoided.

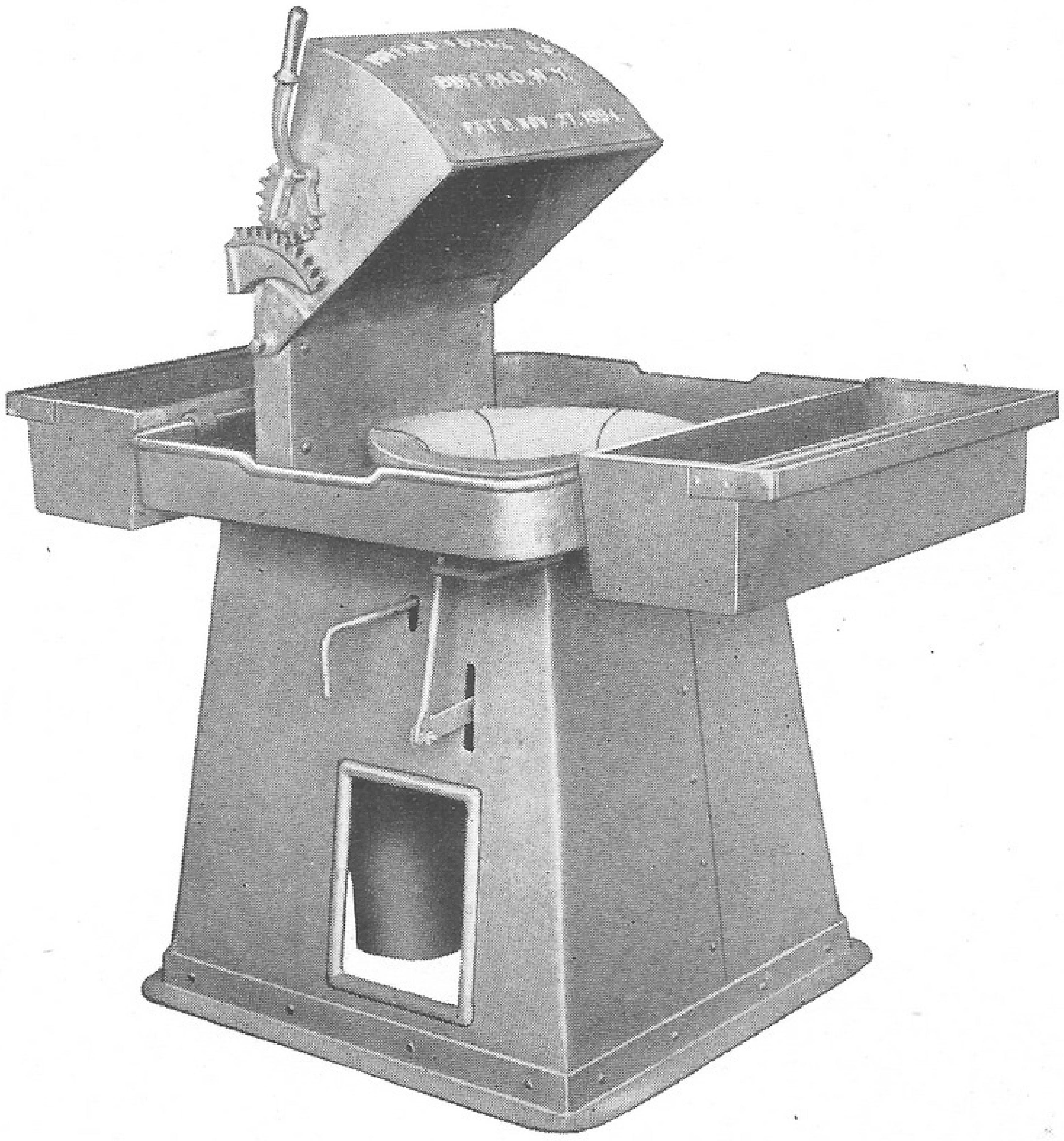
Layout of Buffalo Double Down-Draft Forges



Buffalo Stationary Down-Draft Forge



FIRE BRICK LINING FOR POT



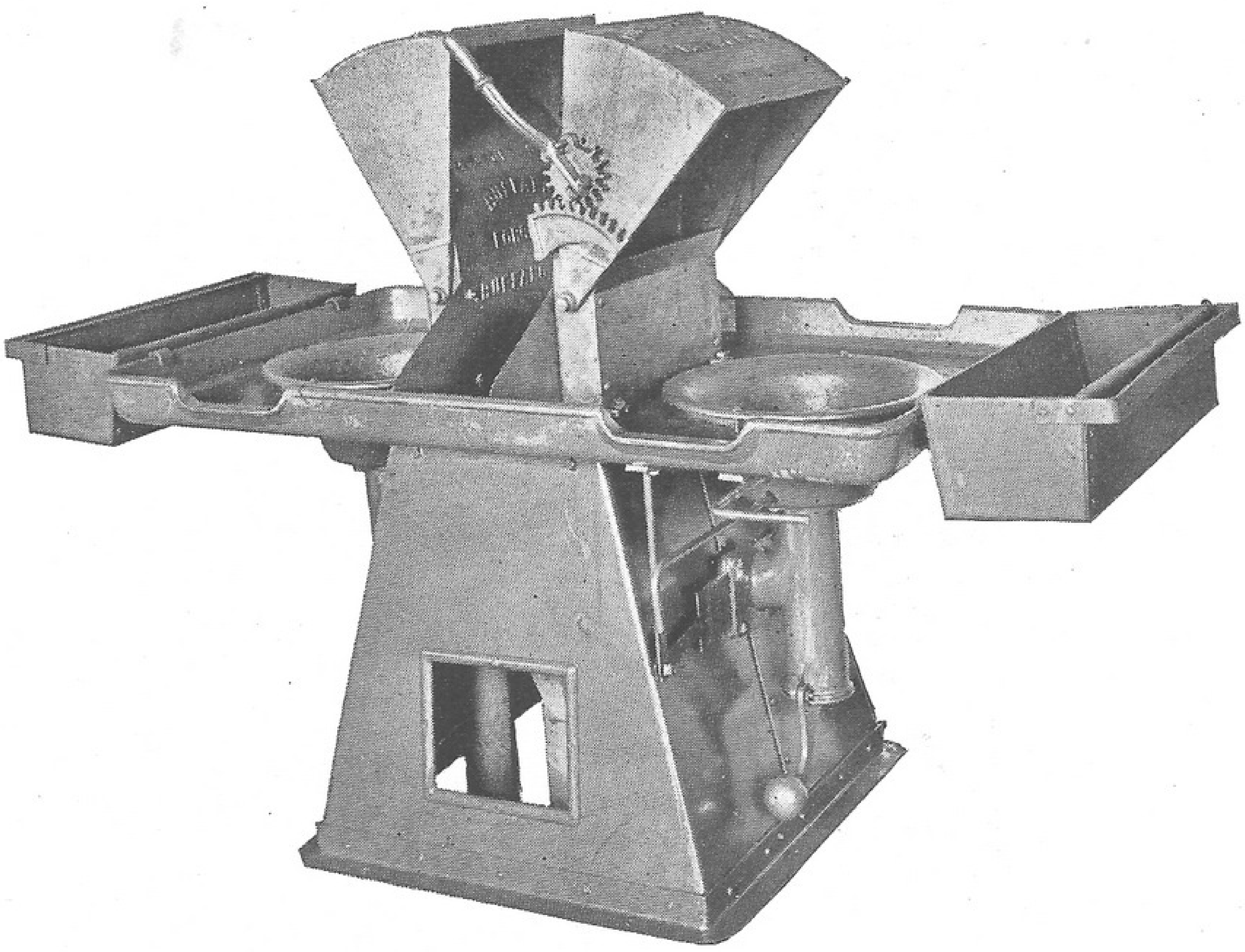
OJD SINGLE FORGE

THE OJD Buffalo Down-Draft Forge was designed especially for Manual Training Schools after a thorough investigation by our engineers among the instructors in a large number of educational institutions. We have adopted no new feature without first trying it out thoroughly under practical conditions and having received the approval of some competent authority. The fire pot is of large dimensions, the walls sloping at an easy angle to a suitable depth, affording ample space for fire clay lining. The damper for regulating the blast of air is of brass to prevent the possibility of corrosion, and is operated by a conveniently located lever. Some instructors prefer a lever operated by the foot for opening and closing the damper, making it necessary for the student to remain at his fire so long as the blast is on, but a great majority prefer the hand-operated gate with lever so that damper can be adjusted to any desired position; it having been proven that where the student desires to leave the forge a weight is placed on the foot lever, and the forge is left with the blast on at full force. The foot lever attachment can be supplied with any of our Manual Training Forges without extra charge when so specified, but the hand lever is strongly recommended.

SPECIFICATION

Single OJD Buffalo Patented Down-Draft Forge of cast iron construction to have a hearth 27″ x 33″ standing 30″ above floor line, and a water tank and coal box at opposite end, each 7″ x 9″ x 28″. The exhaust and blast connections to be of cast iron extending to floor line. The blast connections to be 3″ in diameter and the exhaust connection 6″ in diameter; both to be enclosed in the heavy steel base. Forge to be supplied with work support, Buffalo adjustable down-draft exhaust hood of cast iron, having a stationary back and an adjustable cover. Tuyere to be of the Buffalo anti-clinker dumping type. The blast pipe to have a lever blast gate equipped with a brass slide and arranged with lever for hand control. The stand of each forge is to be supplied with an opening for removing ashes.

Buffalo Stationary Down-Draft Forge



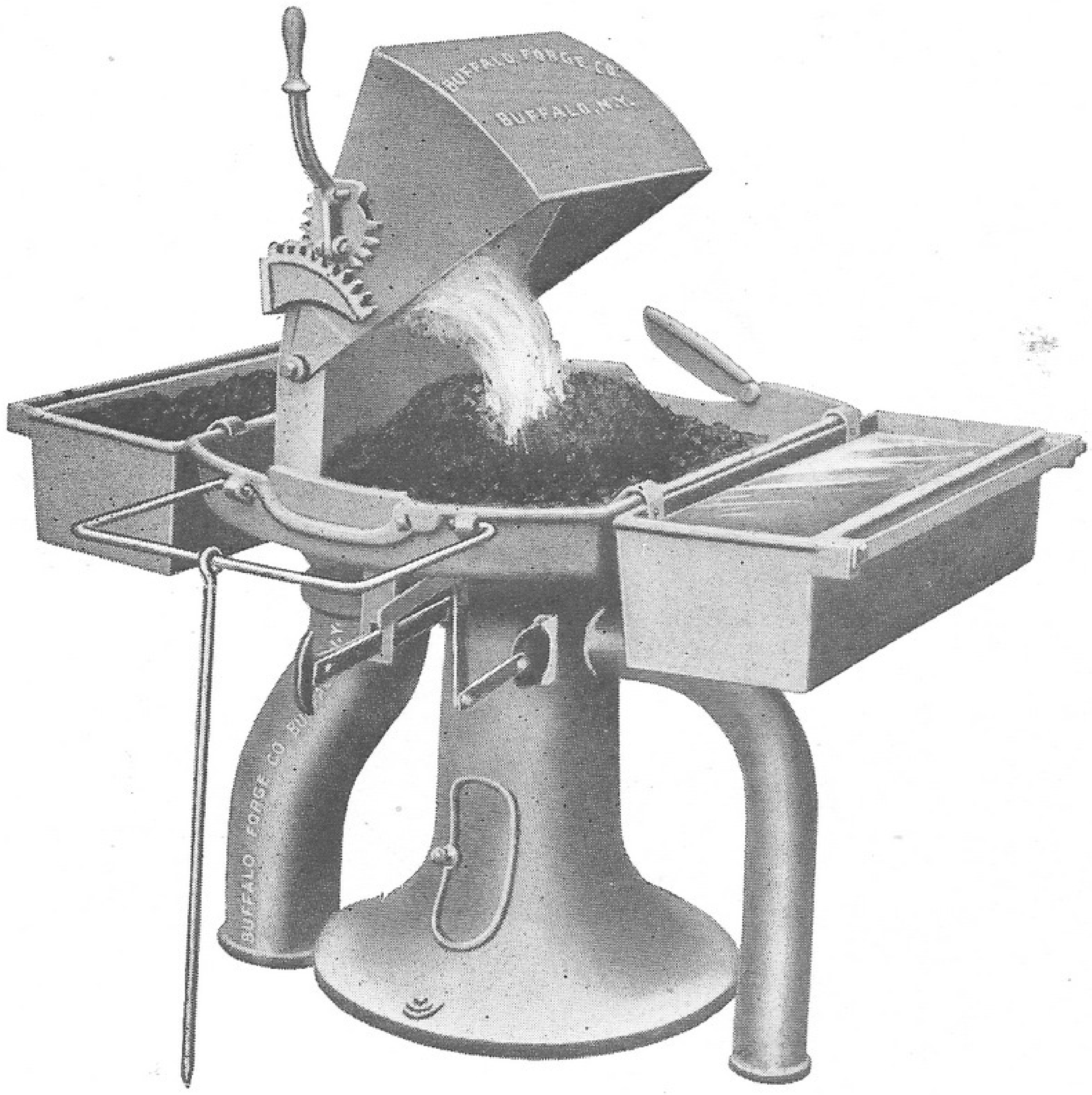
OJD DOUBLE FORGE

THE Double OJD Buffalo Down-Draft Forge is, with reference to details, of the same general construction as the single OJD, except it is more compact and is recommended where a maximum number of forges are to be installed in the space available. Instead of having two separate coal boxes the space between the two down-draft hoods is utilized as a coal bunker and steel plates have been added to each side to increase the capacity. The illustration on opposite page shows the fire pot removed from the forge and illustrates the special fire brick which we have designed for use exclusively with the OJD type forges. These are made up in six sections so that any part can be renewed without having to put in a complete new lining. These may be supplied with either the single or double OJD Forge at a net price of $1.00 per fire pot.

SPECIFICATION

Double OJD Buffalo Patented Down-Draft Forge of cast iron construction to have double hearth 57″ x 34″ cast in one sheet standing 30″ above floor line, and water tank at either end 6½″ x 9″ x 28″. To have cast iron Y exhaust connections, and cast iron blast connections extending to floor line. At the floor line the blast connections to be 3″ in diameter, the exhaust connections 8″ in diameter; both to be enclosed in the heavy steel base. There shall be a space provided for green coal between the hoods. Each forge is to be supplied with a work support, Buffalo adjustable down-draft exhaust hood of cast iron, having a stationary back and an adjustable cover. Tuyere to be of the Buffalo anti-clinker dumping type. The blast pipes to have a lever blast gate equipped with brass slide and arranged with lever for hand control.

Buffalo Stationary Down-Draft Forge



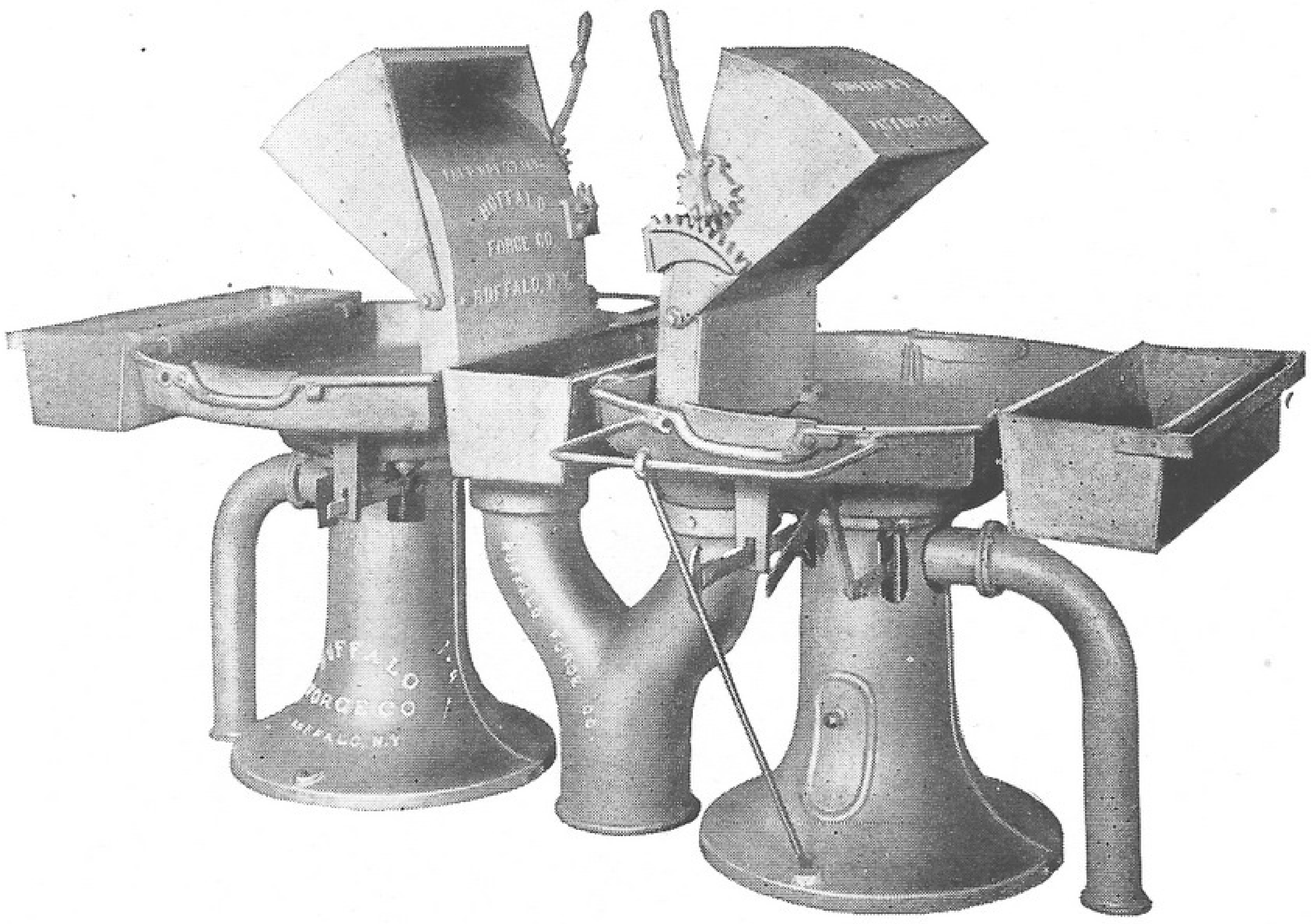
O2D SINGLE FORGE

THE O2D Buffalo Down-Draft Forge has been considered standard for Manual Training Schools for the past 18 years, and is recommended where the funds available are limited, and a thoroughly reliable, practical forge is desired. All features are incorporated in this forge which are necessary to make it complete. The brass damper is an added feature; all other parts are the same as we have been supplying for years. These single forges are recommended where there is sufficient space available for installing all the forges which will ever be required. This forge is also built in pairs as illustrated on opposite page.

SPECIFICATION

Single O2D Buffalo Patented Down-Draft Forge of cast iron construction to have fire pan 24″ x 36½″ standing 29″ above floor line. Forge to have a 3″ blast and 6″ exhaust cast iron connections extending to floor line. To be equipped with tool rack, work support, Buffalo adjustable down-draft exhaust hood of cast iron, having a stationary back and an adjustable cover, and to have a water tank and coal box each 27″ x 9″ x 6½″ located at opposite ends of forge. Tuyere to be of the Buffalo anti-clinker dumping type. The blast pipe to have a lever blast gate equipped with a brass slide and arranged with lever for hand control. The stand is to be supplied with a clean-out door for removing ashes.

Buffalo Stationary Down-Draft Forge



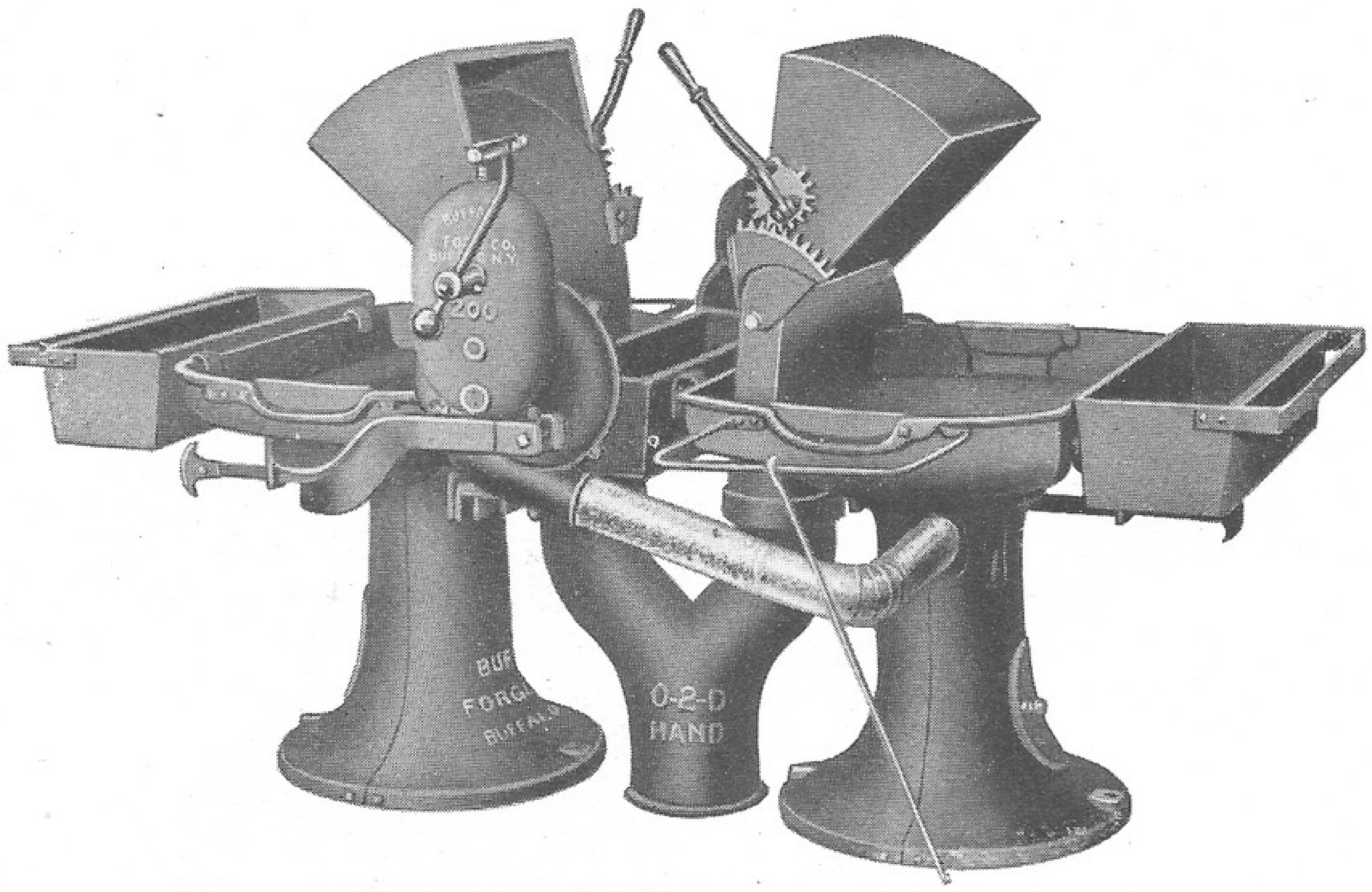
O2D DOUBLE FORGE

THE Double O2D Buffalo Down-Draft Forge is in design practically the same as the single, except the "Y" exhaust connection which is so arranged that two single forges are placed back to back offering economy in floor space. All O2D Forges may be built either right- or left-hand, and this should be taken into consideration when an installation is contemplated, as it often simplifies the arrangement of underground ducts and locates the anvils more conveniently to light, etc. Since the students are located on opposite sides of the double forges they do not interfere with each other in any way.

SPECIFICATION

Double O2D Buffalo Patented Down-Draft Forge of cast iron construction to have fire pan 24″ x 36½″ standing 29″ above floor line. These forges to be arranged in pairs, back to back with cast iron Y exhaust connections, and cast iron blast connections extending to floor line. Each forge is to be equipped with tool rack, work support, Buffalo adjustable down-draft exhaust hood of cast iron, having a stationary back and an adjustable cover, and each pair of forges to have two water tanks 27″ x 9″ x 6½″ placed at opposite ends of forges, and one coal box 27″ x 9″ x 6½″ located between the hoods. Tuyere to be of the Buffalo anti-clinker dumping type. The blast pipes to have lever blast gates equipped with a brass slide and arranged with lever for hand control. The stand of each forge is to be supplied with a clean-out door for removing ashes.

Buffalo Stationary Down-Draft Forge



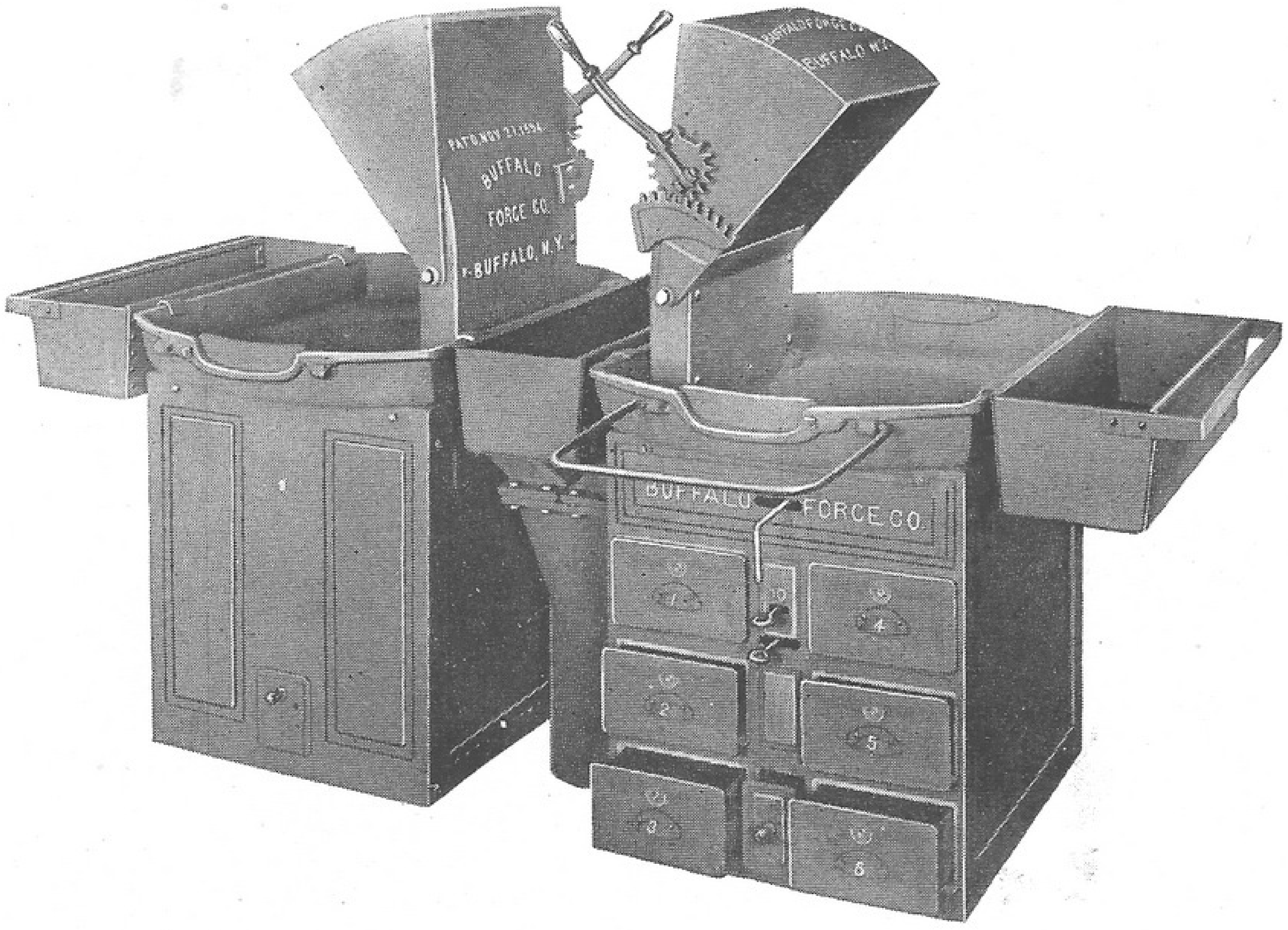
O2D DOUBLE FORGE WITH HAND BLOWER

ANY of the Manual Training Forges of either the single or double type can be furnished with an individual hand blower, and where economy in both first cost and power required for driving the fans is to be considered these are recommended. The hand blower requires the student's presence at the forge during heating and, therefore, has a tendency to teach him how to attain a good welding heat. The hand blower is the famous Buffalo No. 200, all gears of which are machined and run in an oil-proof case. All end thrust is balanced on an adjustable ball bearing. The fan shaft runs in the best grade radial ball bearings. The high speed pinion runs in a bath of oil, lubricating all other working parts by the splash system. The one piece gear case insures permanent alignment of the gears. When the hand blower is used for supplying the blast it is, of course, necessary to use an exhaust fan for removing the smoke and gases, as in other down-draft installations.

SPECIFICATION

O2D Buffalo Down-Draft Patented Forge of cast iron construction to have fire pan 24″ x 36½″ standing 29″ above floor line. Forge to have a 3″ blast connection attached to discharge of hand blower and 6″ cast iron exhaust connection extending to floor line. Each forge is to be equipped with tool rack, work support, Buffalo adjustable down-draft exhaust hood of cast iron, having a stationary back and an adjustable cover, and to have one water tank and coal box each 27″ x 9″ x 6½″ located on opposite end of the forge. Tuyere to be of the Buffalo anti-clinker dumping type. The stand is to be supplied with a clean-out door for removing the ashes. The Hand Blower is to be of the No. 200 Buffalo silent type having 14″ fan case of the involute type, and a discharge 3″ outside diameter, which is to be attached to the blast pipe of the forge through heavily galvanized steel connections. The gears are to run in a bath of oil in an enclosed dust- and leak-proof case. The gears are all to be carefully machined. To operate on the highest grade radial ball bearings. End thrust carried on an adjustable ball bearing.

Buffalo Stationary Down-Draft Forge



OB DOUBLE FORGE

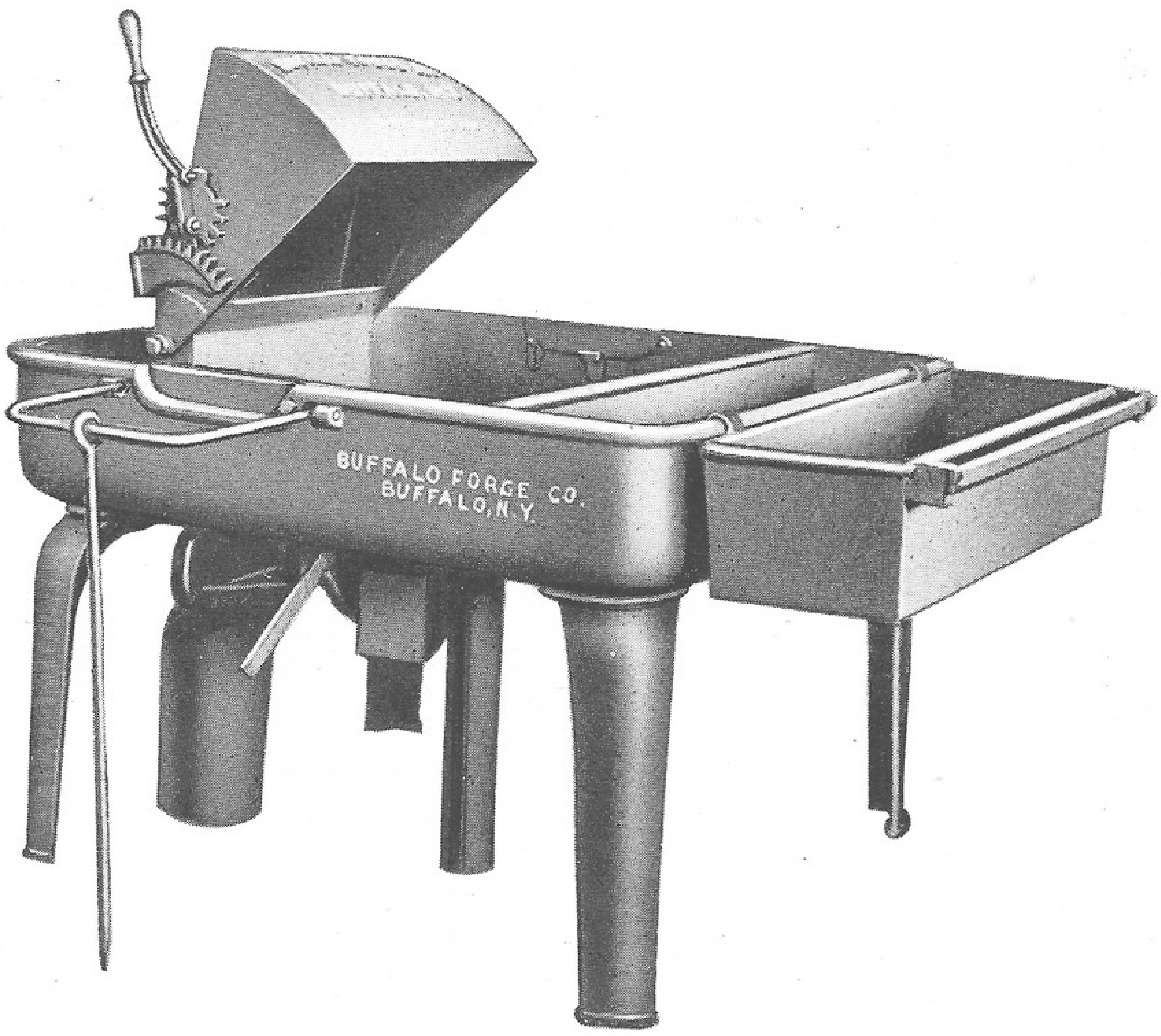
THE Buffalo OB Forge, in addition to containing all the features of the O2D, is equipped with six drawers each of ample capacity for carrying a complete set of tools for the student. This forge is especially recommended where different sets of students work in the forge shop in relays. It enables several different students to use the same forge without the possibility of getting the work or individual tools mixed. The usual practice is to have the drawers open on the opposite side from the anvil when the forges are arranged in pairs, so that the student working on one forge uses the drawer on the other. All drawers are equipped with individual locks and two master keys furnished with each equipment.

In a large number of installations the lockers are placed along the wall in the forge shop, but where floor space is limited the OB Forge is recommended.

SPECIFICATION

OB Buffalo Down-Draft Patented Forge of cast iron construction to have fire pan 24″ x 36½″ standing 29″ above floor line. Each forge to have a 3″ blast and 6″ exhaust cast iron connections extending to floor line. Each forge to be equipped with tool rack, work support, Buffalo adjustable down-draft exhaust hood of cast iron, having a stationary back and an adjustable cover, and to have one water tank and coal box each 27″ x 9″ x 6½″ located on opposite end of the forge. Tuyere to be of the Buffalo anti-clinker dumping type. Blast pipe to have a lever blast gate equipped with a brass slide and arranged with lever for hand control. The stand is to be supplied with a clean-out door for removing the ashes. Each forge is to be equipped with six drawers made of heavy sheet steel with cast iron front, and equipped with individual locks. Inside dimensions of each drawer being 24″ x 7¾″ x 4½″ deep. Space between drawers closed off by sheet steel to prevent inter-communication. Drawers to run on rollers and to work perfectly smooth and easy. Heavy sheets of asbestos to be placed between top drawers and fire pan.

Buffalo Instructor's Stationary Down-Draft Forge



OOSD FORGE

Instructor's Forge

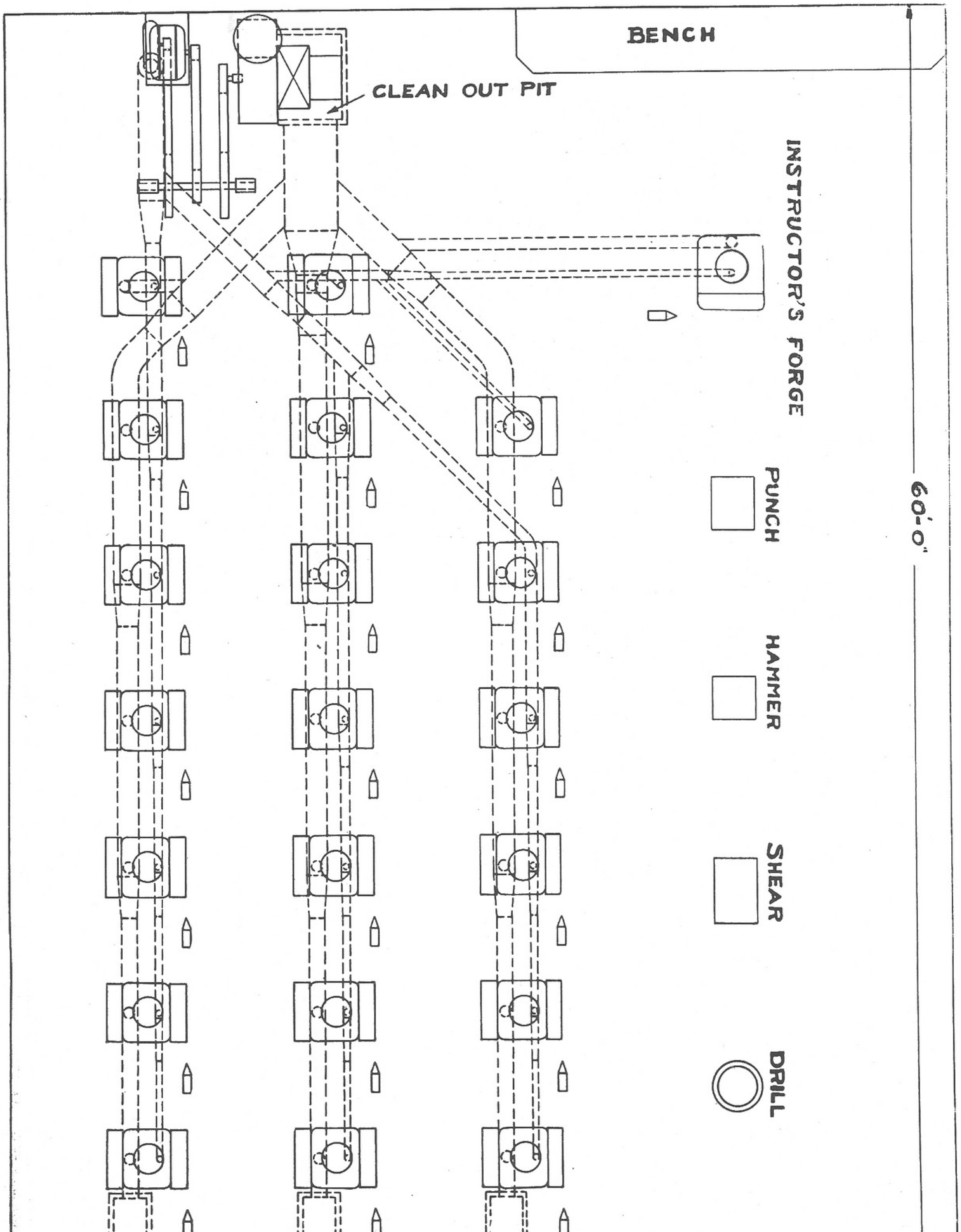
IT is the usual practice to have one larger forge used by the Instructor for demonstrating purposes, and the OOSD illustrated above is recommended, having met the hearty approval of a large number of Instructors. It is of very rugged construction throughout, has a large hearth measuring 38″ x 42½″. The fire pan is 8″ deep and is equipped with a gate on each side which, when open, lowers the sides 2″. This makes it possible to bank the fire to an unusual depth or to line the fire pan with fire brick if desired. The tuyere is of extra heavy construction and of the anti-clinker dumping type.

SPECIFICATION

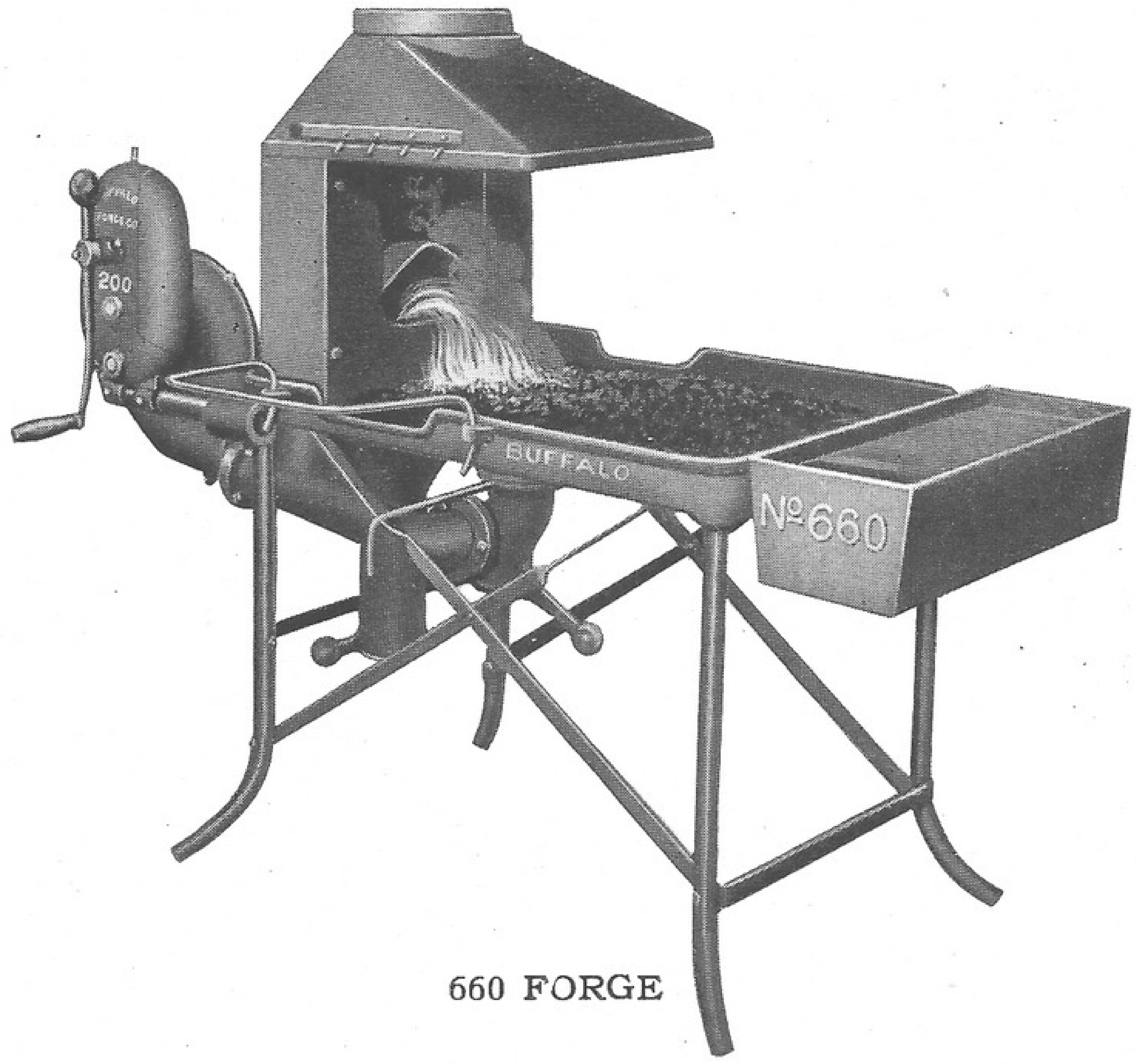
OOSD Buffalo Down-Draft Patented Forge of cast iron construction having a fire pan measuring 38″ x 42″ standing 26½″ above the floor line. Forge to be equipped with work support, Buffalo adjustable down-draft exhaust hood of cast iron, having a stationary back and an adjustable cover and equipped with independent water tank; the coal box forming an integral part of the forge. Tuyere to be of the Buffalo anti-clinker dumping type. The blast pipe to have a lever gate equipped with brass slide and arranged with lever for hand control. Blast and exhaust connections to be of cast iron extending to floor line. The blast is 3″ in diameter and the exhaust 6″.

Typical Layout of School Forge Shop

Forges Arranged Singly



Buffalo Induced-Draft Forge



660 FORGE

EQUIPPED WITH BUFFALO NO. 200 SILENT BLOWER AND "VULCAN" TUYERE

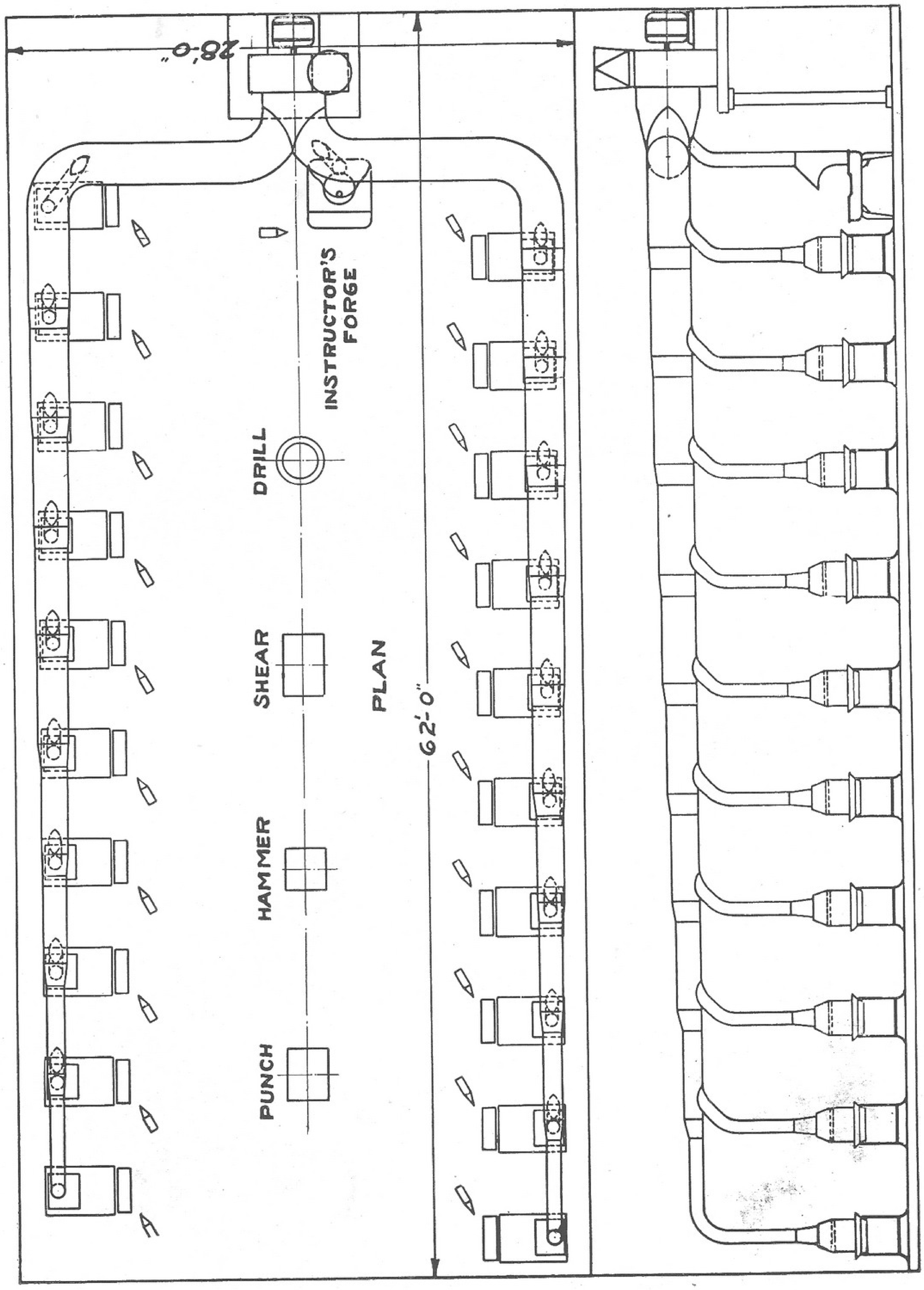
SPECIAL attention is called to an idea which is rapidly gaining ground among the Manual Training Instructors for the use of a forge with hand instead of power blast, and which contains also the advantages of the down-draft feature. The 660 Forge illustrated above contains these features, and by its use the first cost is considerably reduced. The forge has the latest improved form of geared hand blower, and considerable economy is effected by the recirculation of the unconsumed products of combustion. Operating conditions are practically the same as found in the ordinary small blacksmith shop, the cost of the power, blower and the blast piping is eliminated, and the expense of power for operating the blast is saved. At the same time, it is impossible for the boys to burn up and waste material by carelessly leaving the blast gate open or forgetting that the work is in the fire. This has been thoroughly tried out in a number of the leading institutions, and the instructors are very enthusiastic and recommend this arrangement in preference to the stationary forge with power blast.

These forges may be used with natural draft, but for a large installation it is preferable to use an exhaust fan, placing the piping overhead. An arrangement of this kind is illustrated on opposite page.

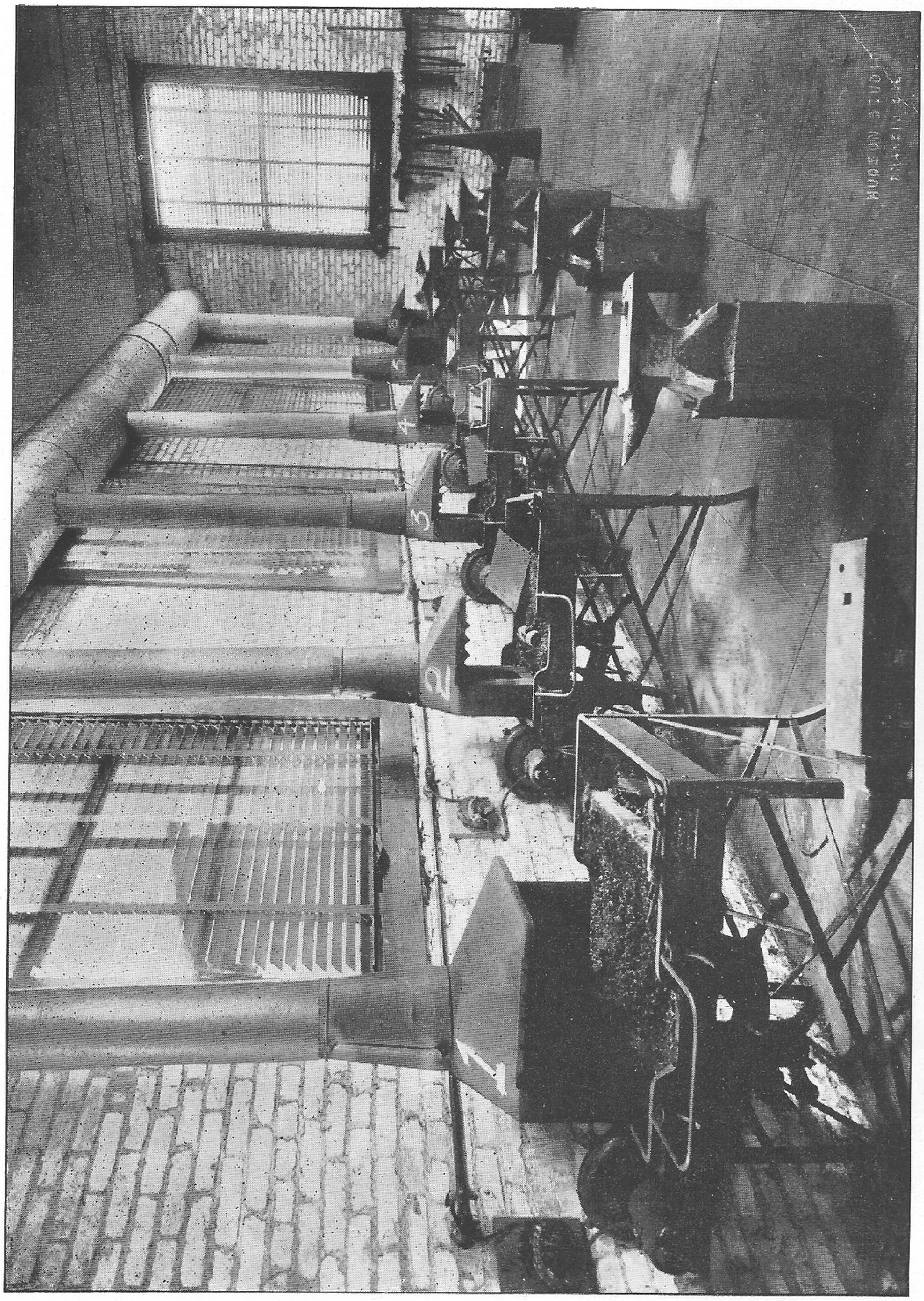
SPECIFICATION

660 Buffalo Portable Induced-Draft Forge having fire pan 28″ x 40″, equipped with Buffalo overhead down-draft exhaust hood recirculating a portion of the gases, thereby increasing the temperature of the blast and increasing the natural draft on the forge. To be equipped with water tank 27″ x 9″ x 6½″ in depth. The tuyere is to be of the Buffalo anti-clinker dumping type. The stand is to be supplied with a clean-out door for removing the ashes. The Hand Blower is to be of the No. 200 Buffalo silent type having 14″ inch fan case of the involute type, and a discharge 3″ outside diameter, which is to be attached to the blast pipe of the forge by heavily galvanized steel connection. The gears are to run in a bath of oil in an enclosed, dust- and leak-proof case. The gears are all to be carefully machined. To operate on the highest grade radial ball bearings. End thrust carried on an adjustable ball bearing.

Buffalo Induced-Draft Forge

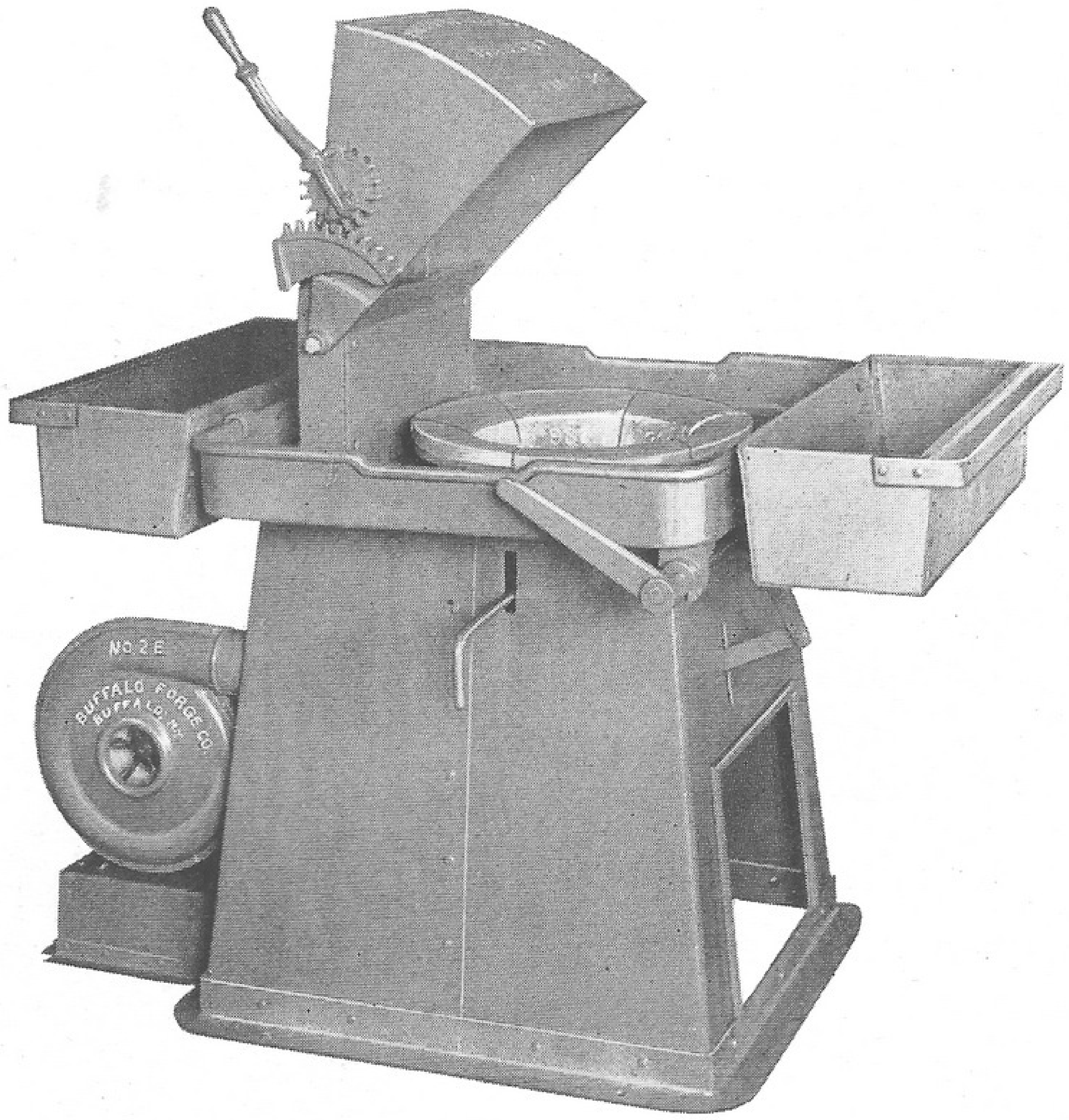


LAYOUT OF SHOP WITH NO. 660 FORGES



660E PORTABLE INDUCED-DRAFT FORGES WITH INDIVIDUAL ELECTRIC BLOWERS AND OVERHEAD EXHAUST
ANAHEIM HIGH SCHOOL, ANAHEIM, CAL.

Buffalo Down-Draft Electric Forge



OJD ELECTRIC FORGE

THE above illustration shows the single OJD Down-Draft Forge described on page 6 and equipped with an individual electric blower. There are a number of advantages with this arrangement and it is gaining in popularity. It does away with the necessity of underground blast piping, making the installation less expensive, and the power required for supplying blast to a number of forges is considerably less, due to the frictional loss thru long runs of piping being reduced to a minimum. Furthermore, the motors are not in use except when the particular forge with which they are used is being operated, while in the case of one large blower for serving a number of forges, it is occasionally necessary to operate same when only a few forges are in use.

The No. 2E Buffalo Electric Forge Blower equipped with a variable speed motor and controller is usually employed. The regulator may be attached to front of forge, convenient to the student, enabling him to readily vary the speed to suit the nature of the work being done. With the lever of the regulator on the first stop, the circuit is open, making it very convenient to start and stop the motor.

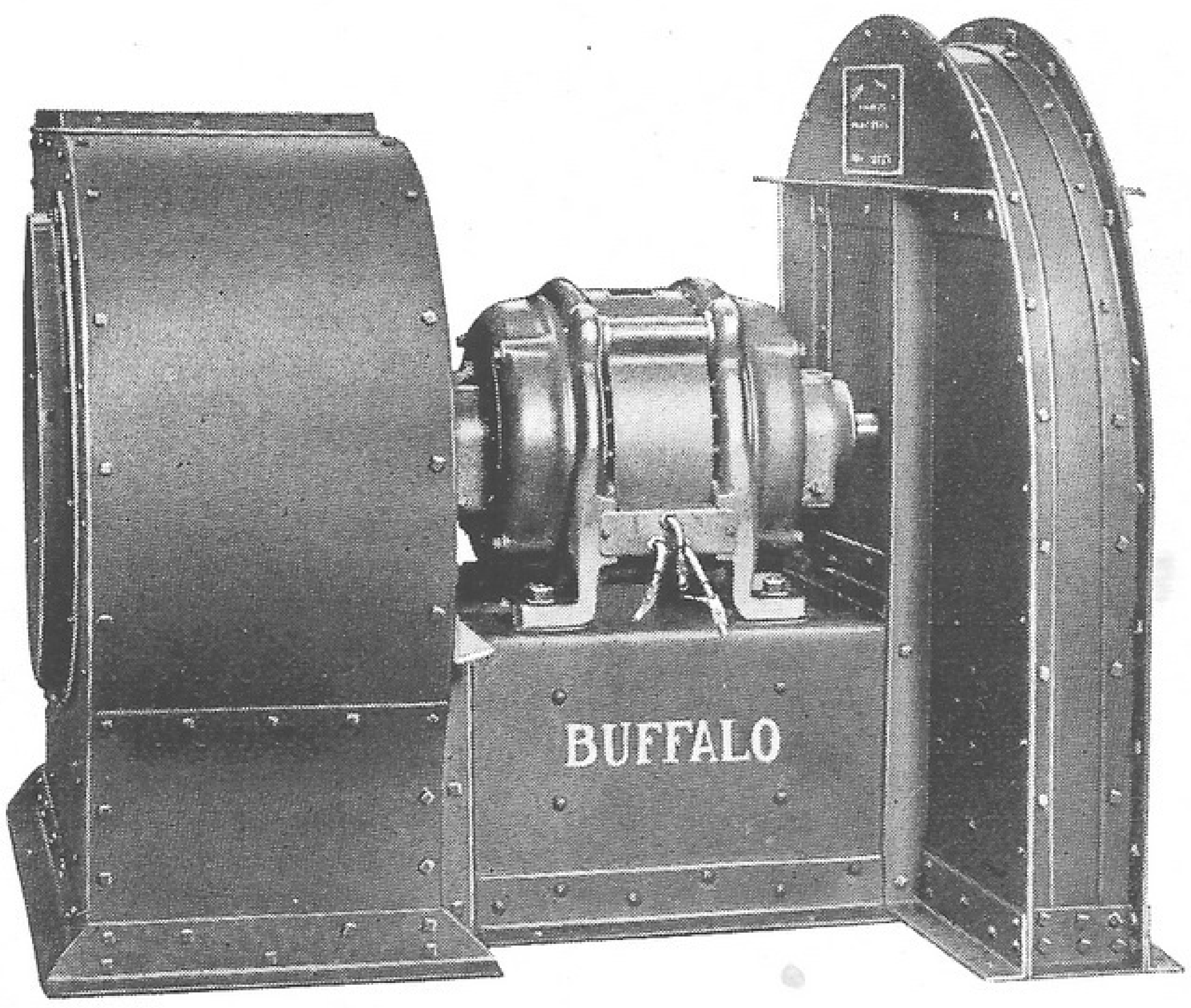
SPECIFICATION

Single OJD Buffalo Down-Draft Patented Forge of cast iron construction to have a hearth 27″ x 33″ standing 30″ above floor line. To have a water tank and coal box on the opposite end, each 7″ x 9″ x 28″. The blast is to be supplied by the Buffalo 2-E Electric Forge Blower with variable speed motor and regulator giving six different speeds. Connection from blowers to tuyere to be 3″ in diameter; the exhaust connection to be 6″ in diameter. Both blast and exhaust connections to be enclosed in a heavy sheet steel base. Forge to be supplied with work support, and the Buffalo adjustable down-draft exhaust hood of cast iron, having stationary stack and adjustable cover. The tuyere to be of the Buffalo anti-clinker dumping type. The stand to be supplied with an opening for removing ashes.

Blowers and Exhausters

FOR every down-draft forge shop installation a Buffalo Exhaust Fan is recommended and is necessary for best results. Natural draft cannot be depended upon for properly removing the smoke and gases from the room. The usual arrangement with the stationary type forge is to place the exhaust ducts below the floor line, constructing same of tiling or galvanized steel laid in concrete, and to place the exhauster in any convenient position; usually on a platform if floor space is limited. The smoke and gases may be discharged immediately up thru the roof or into a stack or flue if convenient. Where a line shaft is available the belted type exhauster is generally installed, but if electricity is available a direct-connected motor-driven exhauster is recommended, as it eliminates all belt trouble, requires less space, very little attention, and is more economical.

A fan of some type is necessary for supplying the blast. One of three types is usually employed, depending upon the size of the installation and other local conditions. One arrangement is to have a centrifugal blower for supplying blast to the entire installation by means of an underground duct, arranged similar to the exhaust system; another is to have individual hand blowers attached to the forges, and the other to have individual electric blowers as previously described. On the following page we give a table showing the proper size fans for any number of forges. A very efficient arrangement where electricity is available and one large fan is used for supplying blast to all the forges is to have the exhauster and blower both connected to one motor, the motor being located between the two fans with a double shaft extension. The blower is necessarily a little more expensive than the standard type, on account of having to be designed to operate at the same speed as the exhauster, but there is a saving in the cost of the motor, also in floor space and in the amount of power required. A number of recent installations have incorporated this feature.



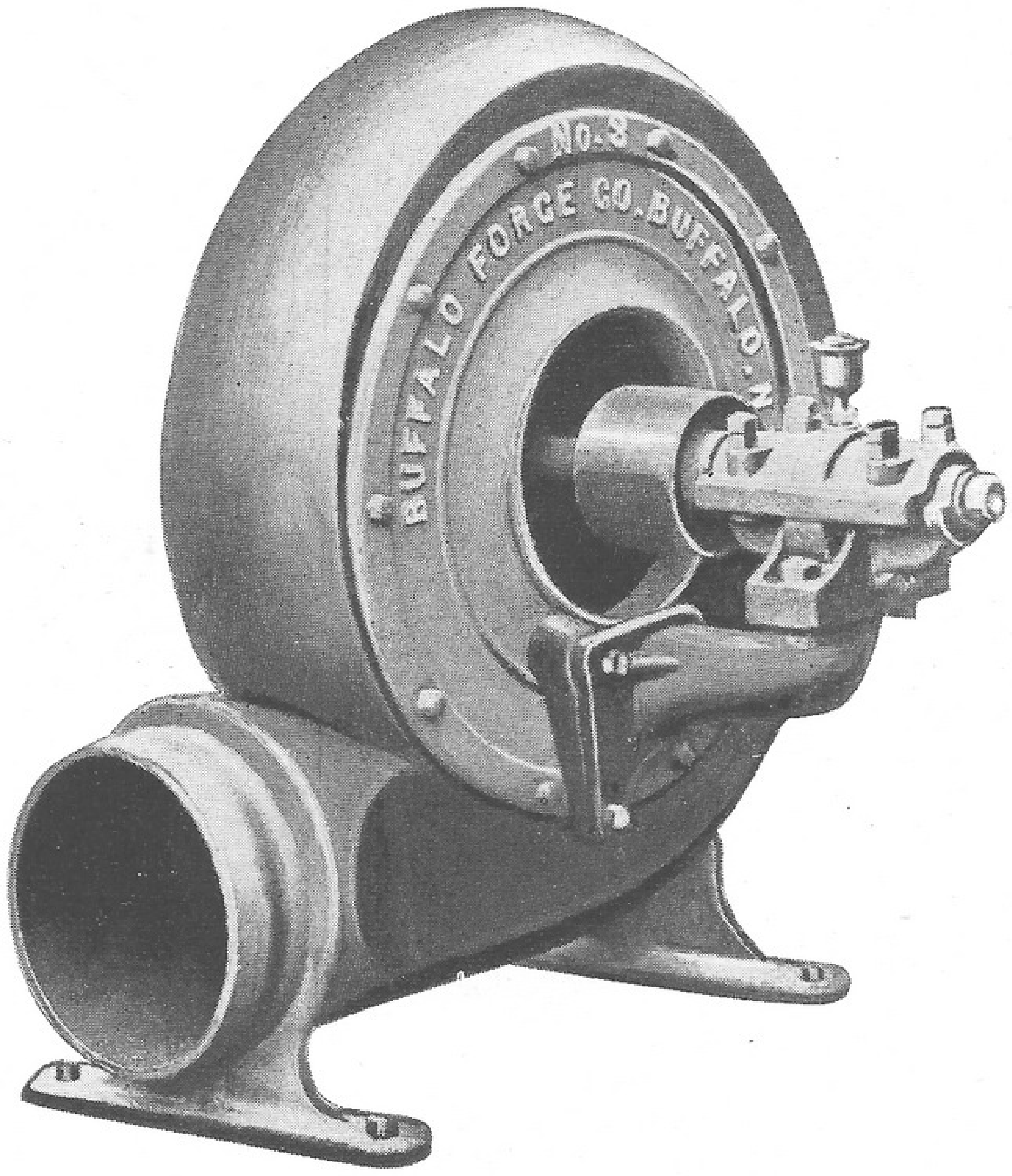
EXHAUSTER AND BLOWER DRIVEN BY ONE MOTOR

Forge Shop Equipment

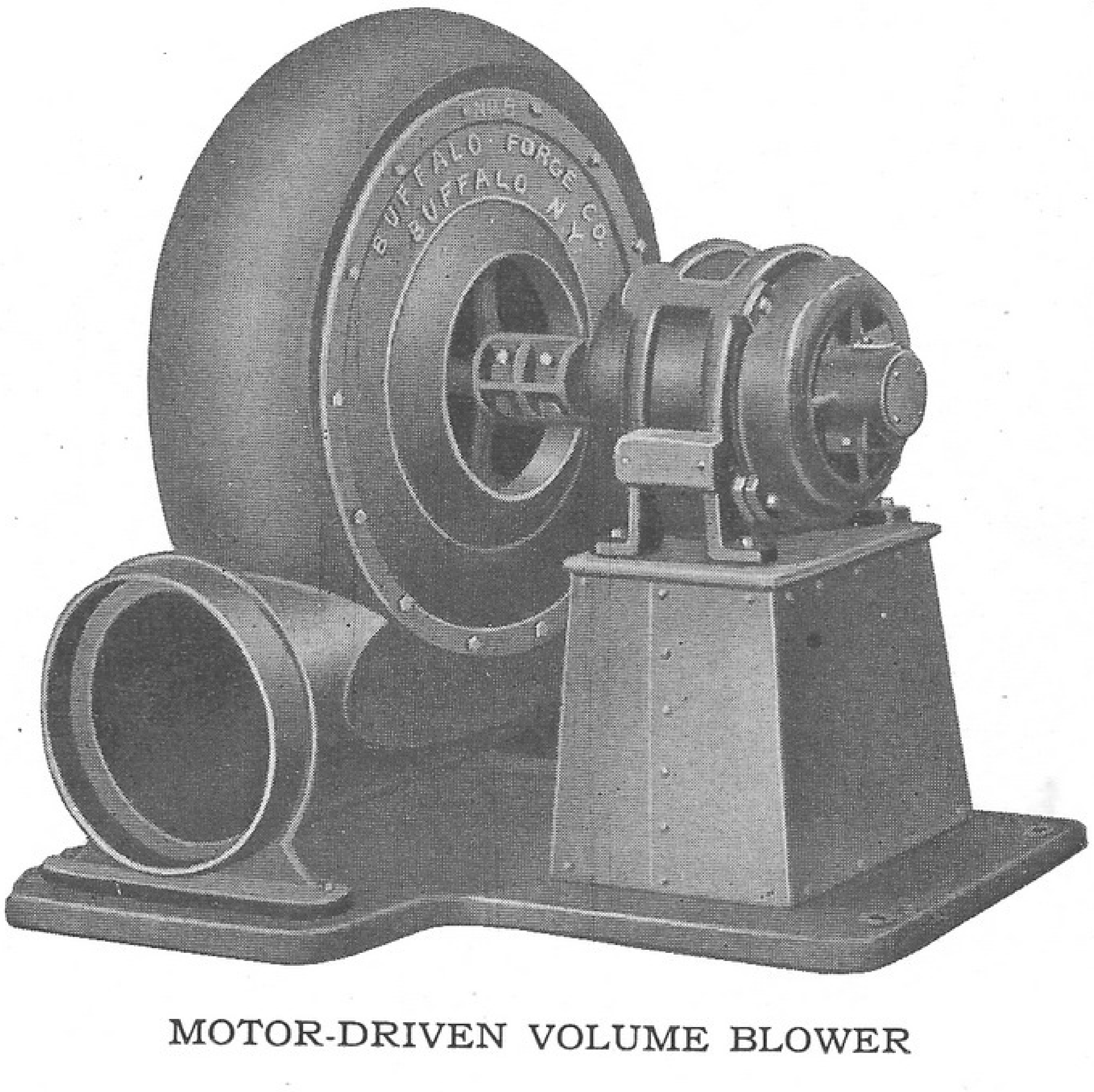
Size of Fans Required for School Forge Shops

Press. of Blast	Num. of Buffalo OJD or O2D Forges	Blast						Exhaust					
		Diam. Main Blast Duct	Steel Press. or B Vol. Blower					Diam. Main Exh. Duct	Exhaust Fan at 1½ Oz. B Vol. or Planoidal St. Pl. Exhauster				
			Blower Size	Diam. Outlet	A. P. M. per Forge	R. P. M.	H. P.		Fan Size	Diam. Inlet	A. P. M. per Forge	R. P. M.	H. P.
2½ Oz. per Sq. In.	1	3″	3 S. P. B.	4¾″	430	3150	0.73	6″	2 B Vol.	6$\frac{1}{16}$″	458	2420	0.34
	2	4″	3 S. P. B.	4¾″	215	3150	0.73	9″	4 B Vol.	9″	507	1490	0.76
	3	5″	3 S. P. B.	4¾″	143	3150	0.73	10″	5 B Vol.	10⅝″	485	1345	1.09
	4	6″	3 S. P. B.	4¾″	107	3150	0.73	12″	6 B Vol.	11$\frac{13}{16}$″	515	1100	1.54
	5	7″	3 S. P. B.	4¾″	86	3150	0.73	14″	30″ Pl.	15″	470	1410	2.08
	6	8″	3 S. P. B.	4¾″	72	3150	0.73	15″	35″ Pl.	17½″	530	1210	2.82
	7	8″	3 S. P. B.	4¾″	61	3150	0.73	16″	40″ Pl.	20″	595	1060	3.68
	8	9″	4 S. P. B.	5″	58	2660	0.78	17″	40″ Pl.	20″	520	1060	3.68
	9	9″	5 S. P. B	5⅜″	57	2330	0.88	18″	45″ Pl.	22½″	585	943	4.66
	10	10″	3 B Vol.	7⅝″	93	2195	1.23	19″	45″ Pl.	22½″	527	943	4.66
	11	10″	3 B Vol.	7⅝″	90	2195	1.23	20″	50″ Pl.	25″	590	848	5.78
	12	11″	3 B Vol.	7⅝″	82	2195	1.23	21″	50″ Pl.	25″	540	848	5.78
3 Oz.	13	11″	3 B Vol.	7⅝″	84	2414	1.62	22″	50″ Pl.	25″	500	848	5.78
	14	11″	3 B Vol.	7⅝″	78	2414	1.62	23″	55″ Pl.	27½″	560	772	6.99
	15	12″	3 B Vol.	7⅝″	73	2414	1.62	23″	55″ Pl.	27½″	525	772	6.99
	16	12″	3 B Vol.	7⅝″	68	2414	1.62	24″	55″ Pl.	27½″	490	772	6.99
	17	12″	3 B Vol.	7⅝″	64	2414	1.62	25″	60″ Pl.	30″	550	707	8.30
	18	13″	3 B Vol.	7⅝″	60	2414	1.62	26″	60″ Pl.	30″	520	707	8.30
	19	13″	3 B Vol.	7⅝″	57	2414	1.62	26″	60″ Pl.	30″	490	707	8.30
	20	14″	3 B Vol.	7⅝″	55	2414	1.62	27″	60″ Pl.	30″	460	707	8.30
3½ Oz.	21	14″	3 B Vol.	7⅝″	55	2590	2.03	28″	70″ Pl.	35″	610	606	11.3
	22	14″	4 B Vol.	9″	70	2270	2.72	28″	70″ Pl.	35″	580	606	11.3
	23	15″	4 B Vol.	9″	67	2270	2.72	29″	70″ Pl.	35″	555	606	11.3
	24	15″	4 B Vol.	9″	65	2270	2.72	30″	70″ Pl.	35″	530	606	11.3
	26	15″	4 B Vol.	9″	60	2270	2.72	31″	70″ Pl.	35″	490	606	11.3
	28	16″	4 B Vol.	9″	55	2270	2.72	32″	80″ Pl.	40″	595	530	14.8
	30	16″	4 B Vol.	9″	52	2270	2.72	33″	80″ Pl.	40″	555	530	14.8

Forge Shop Blowers

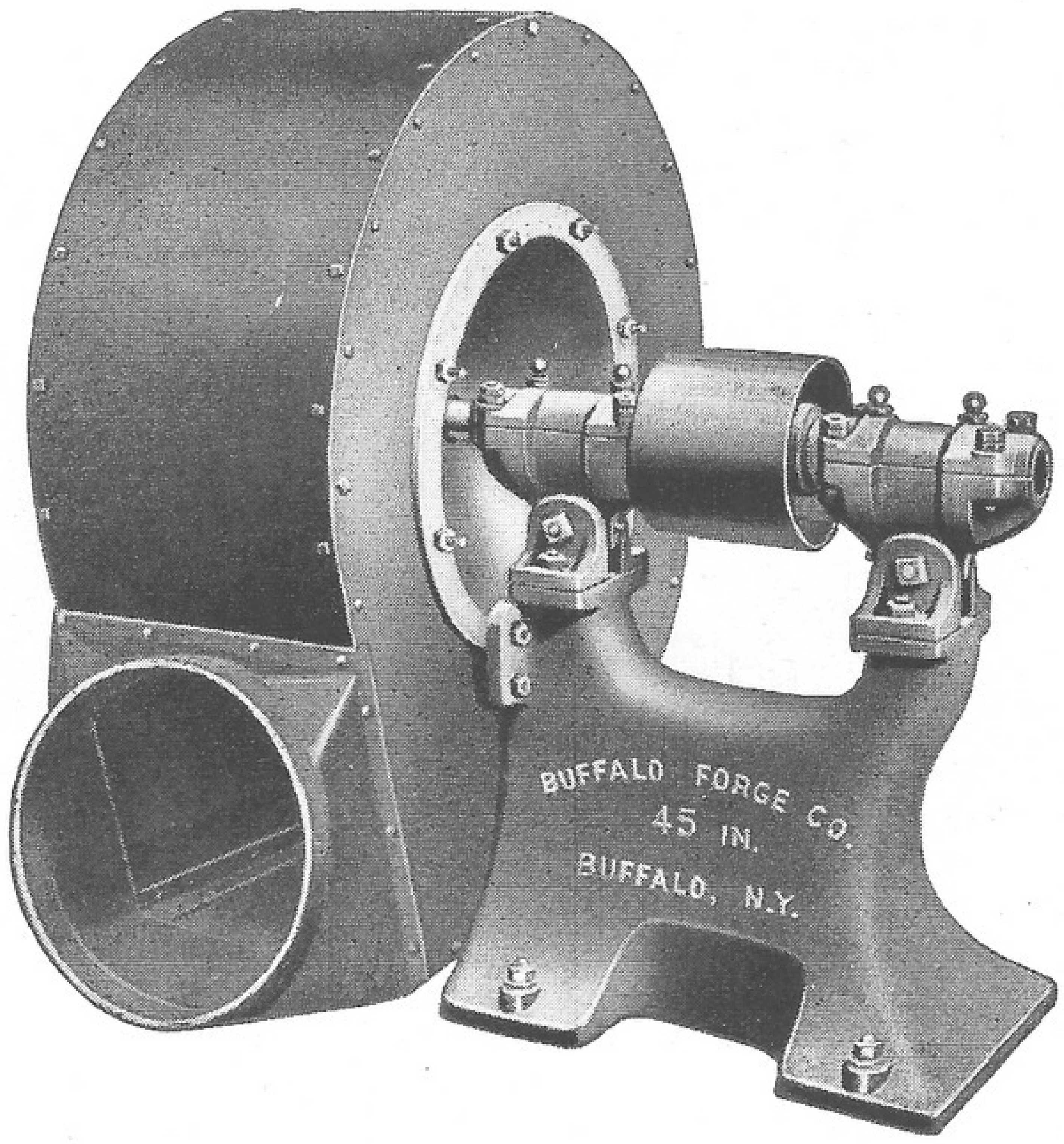


PULLEY TYPE VOLUME BLOWER

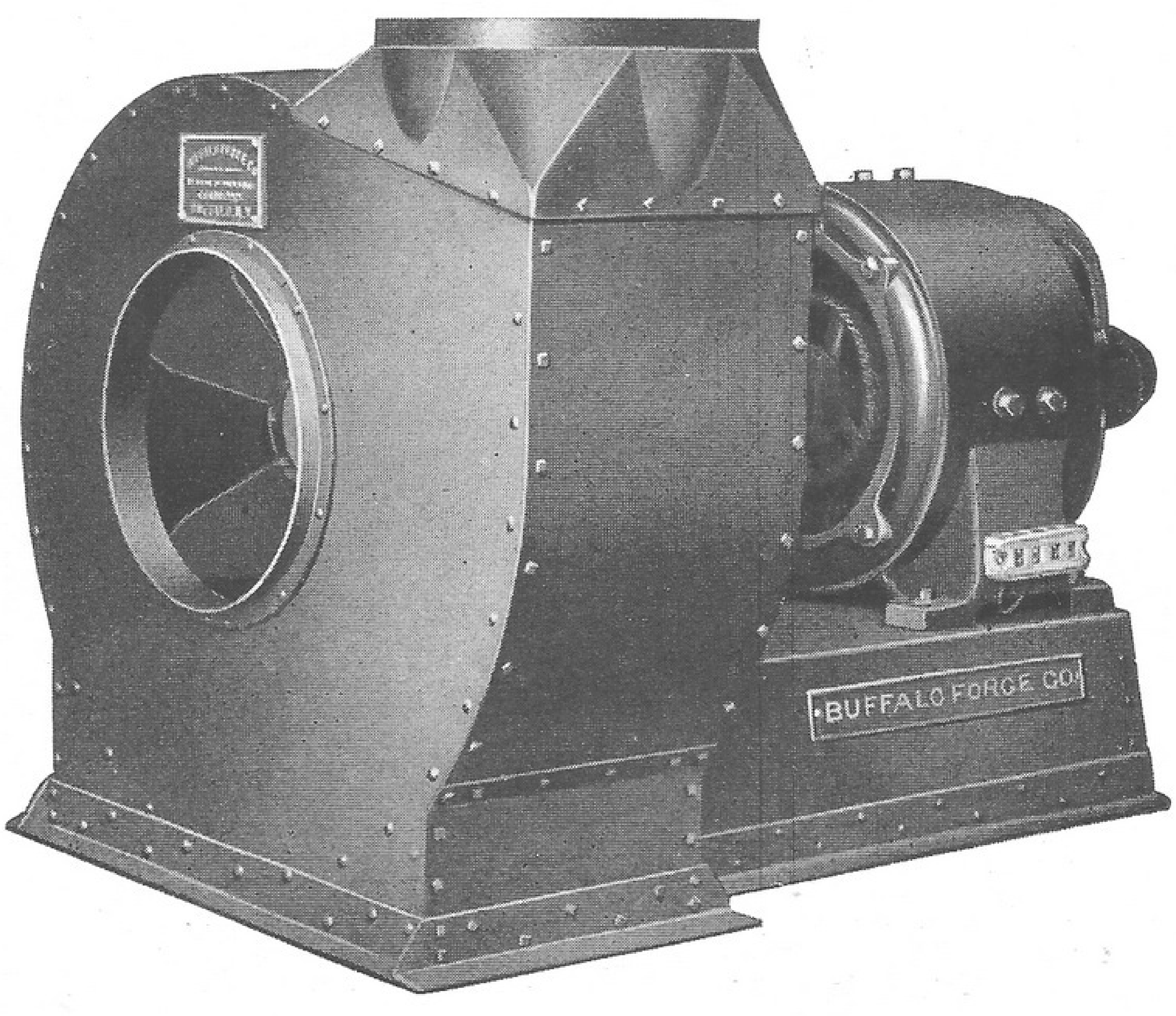


MOTOR-DRIVEN VOLUME BLOWER

Forge Shop Exhaust Fans

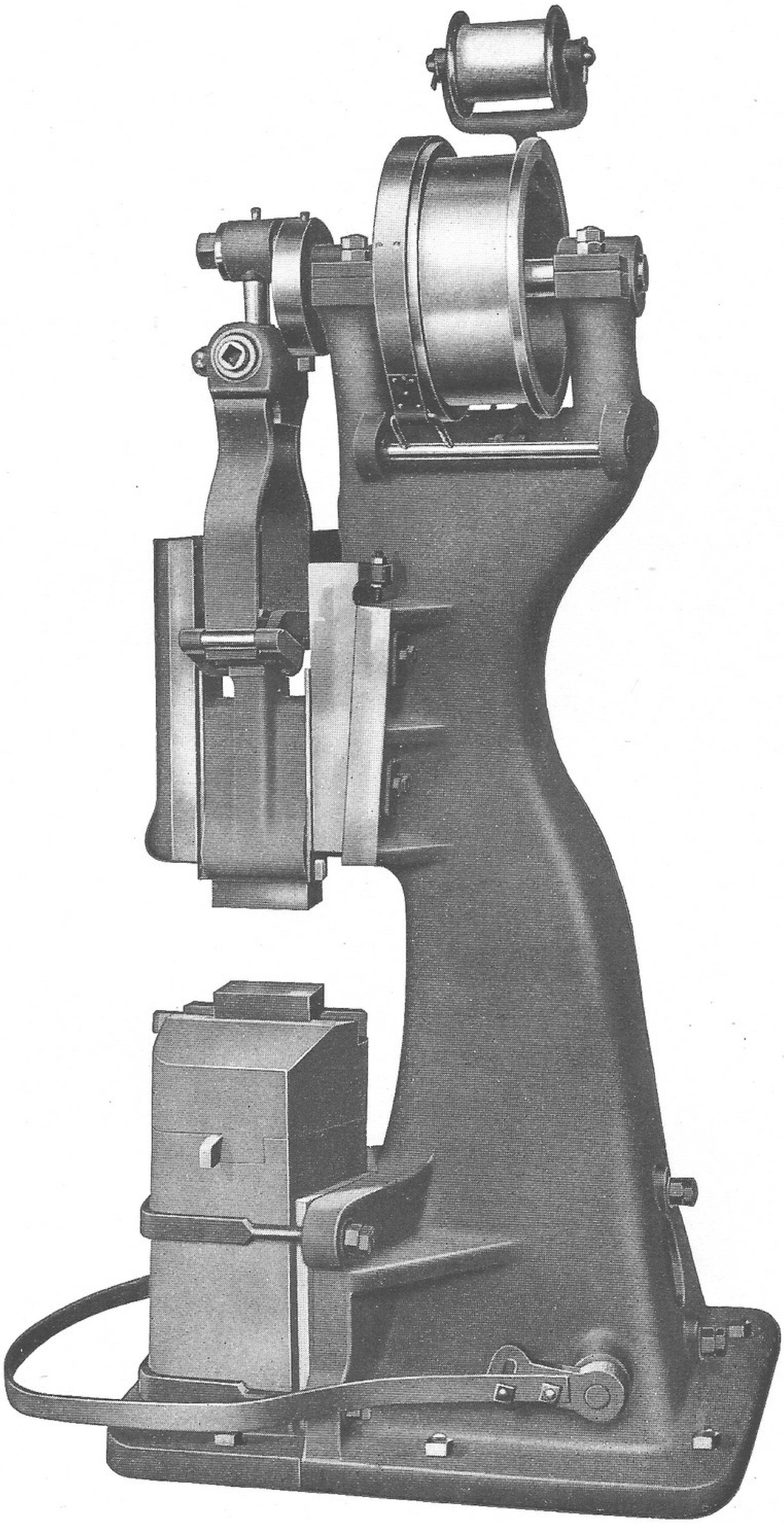


PULLEY TYPE EXHAUSTER



MOTOR-DRIVEN EXHAUSTER

The Beaudry Peerless Power Hammer



The Beaudry Peerless Power Hammer

WE illustrate on the opposite page one of the most useful power hammers for Manual Training and Technical Schools. It is simple, yet powerful and a machine that is an attraction for all students.

It is designed for continuous service and can be operated at a very high rate of speed. Every working part is of steel. The ram is connected with spring arms through two long steel links, arranged to occupy the least space, but giving at the same time the maximum freedom and lift of ram, and imparting through the spring arms a very elastic, cushioned and powerful blow.

The hammer is started, stopped and regulated by a foot treadle extending around the base of machine, and through a varying pressure on which is instantly obtained any desired speed or force of blow. The idle pulley and brake band is reversible and can be attached to either side of driving pulley, through lugs provided for that purpose, so that hammer may be run in either direction as may best suit operator's requirements.

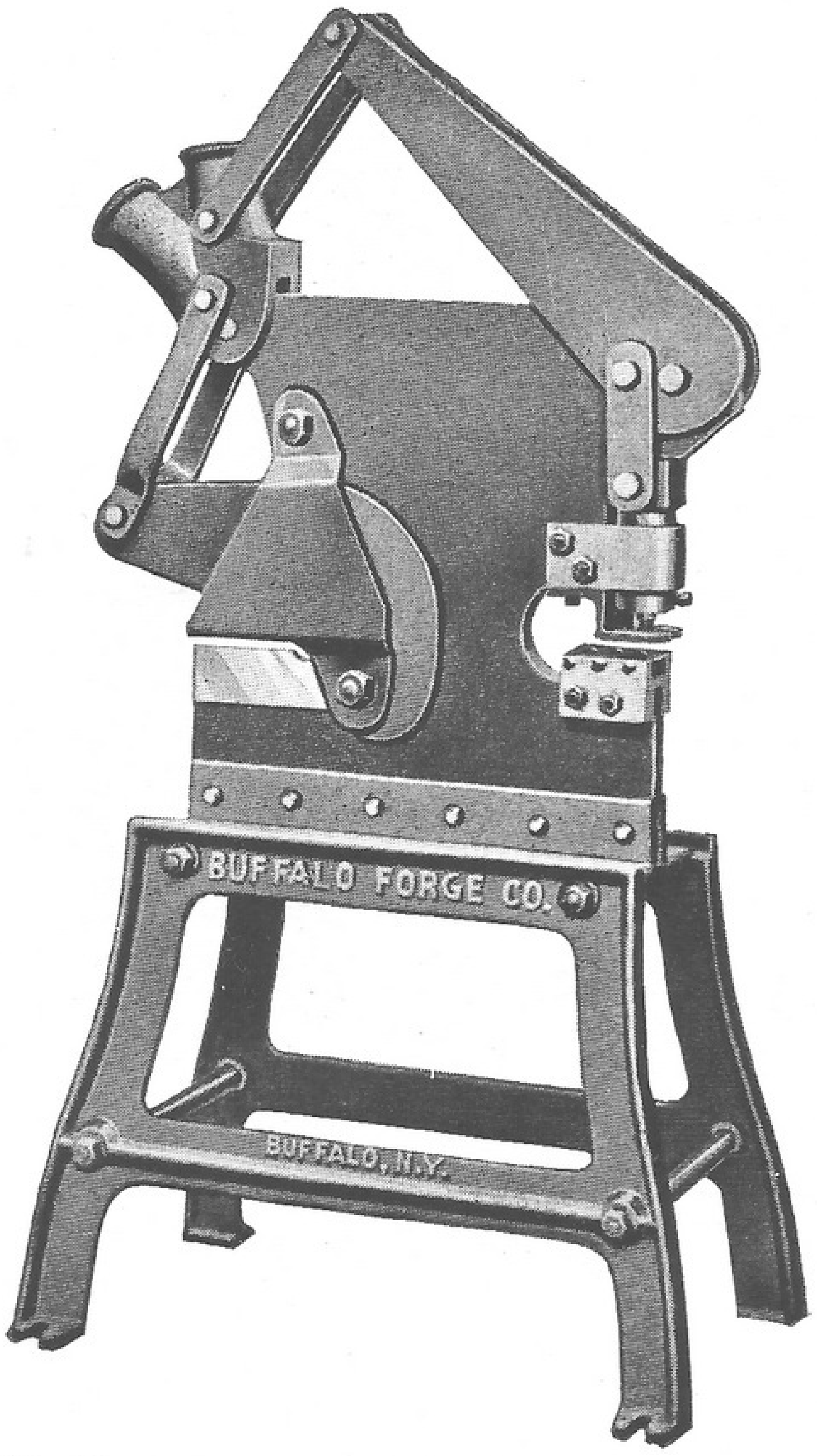
The anvil is a separate casting, flanged at bottom for bolts. A wood filler is used between anvil and frame to eliminate vibration. As shown in cut, the anvil is also secured to frame by means of strap bolts, and is offset so as to clear main frame casting, allowing any length bars to be worked either way of dies. The anvil has an independent and adjustable shoe die.

SIZES AND DIMENSIONS

No. of Hammer	2	3	4	5
Weight of Ram, lbs.	50	75	100	125
Lift of Ram, inches	5½	6	6½	7
Average Size Work, inches	1½	1¾	2¼	2½
Speed of Hammer	350	325	300	300
Diameter of Driving Pulley, inches	15	16	16	16
Face of Driving Pulley, inches	5	5	5½	5½
Height to Center of Shaft, inches	66	68	71	73
Size of Dies, inches	6½ x 3¼	6½ x 3½	7 x 3½	7 x 3½
Approximate Weight of Hammer, lbs.	2000	2400	3000	3200

All sizes have independent anvils. Bars of any length may be worked either way of dies.

Buffalo Armor Plate Tools



NO. 2B, 3B, and 4B PUNCH AND SHEAR

THE frames are of Armor Plate Steel which is so much stronger than cast-iron, we can reduce the weight to less than 25% of the old cast-iron type and still have a stronger machine.

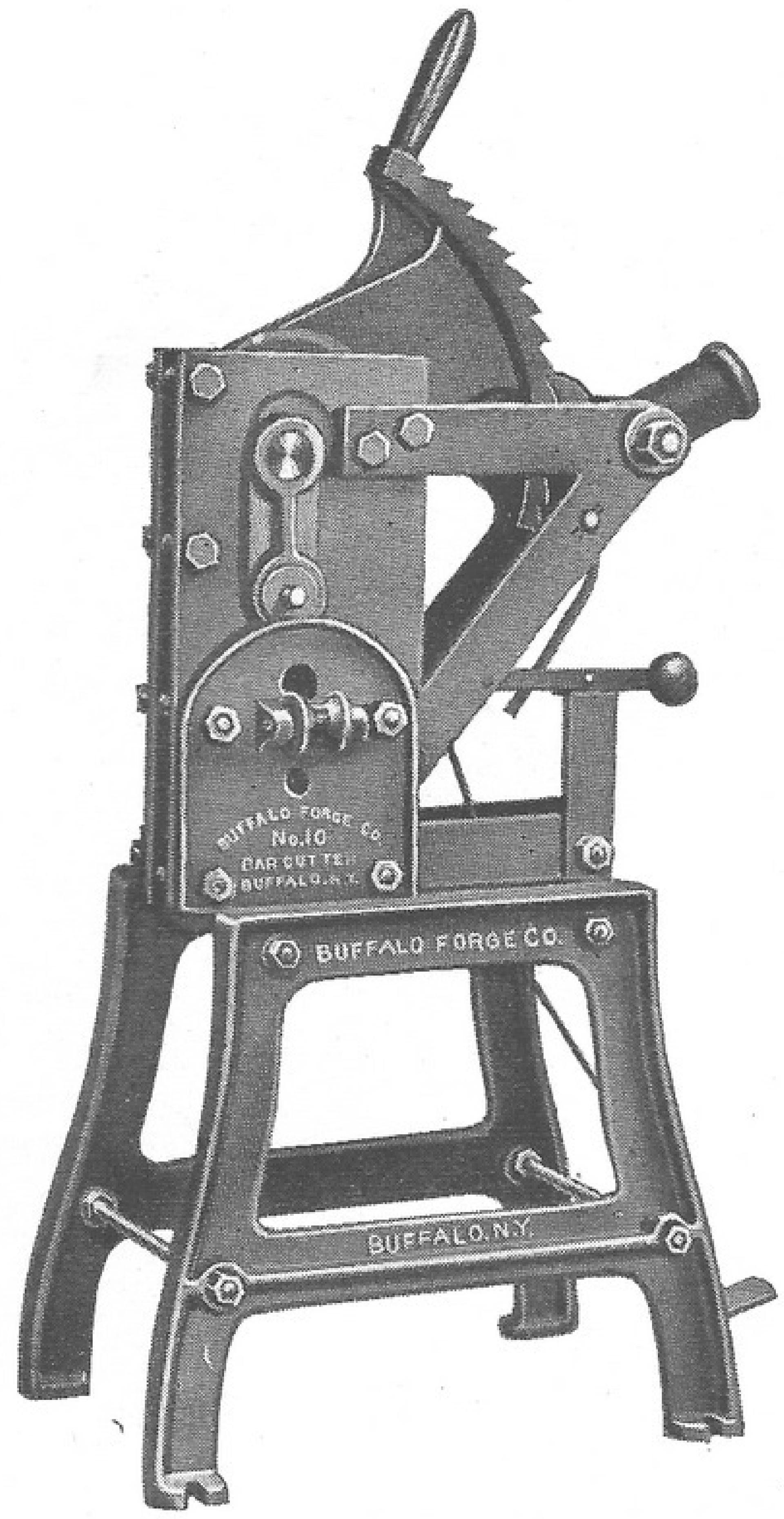
SPECIFICATION

The No. 2B Buffalo Combination Armor Plate Punch and Shear has a capacity to punch 1/4″ holes in 1/4″ metal, cuts rounds 5/8″ in diameter, cuts flats 2″ x 5/16″. It is furnished with three punches, 1/8″, 3/16″ and 1/4″. Depth of throat 3 3/4″, weight 125 lbs.

The No. 3B Buffalo Combination Armor Plate Punch and Shear punches 3/8″ holes in 3/8″ metal, cuts rounds 3/4″ in diameter, cuts flats 3″ x 5/8″. It is furnished with three punches, 1/4″, 5/16″ and 3/8″. Depth of throat 3 3/4″, weight 250 lbs.

The No. 4B Buffalo Combination Armor Plate Punch and Shear punches 1/2″ holes in 1/2″ plate, cuts rounds 1″ diameter, cuts flats 3″ x 5/8″. It is furnished with three punches, 1/4″, 3/8″ and 1/2″. Depth of throat 5 1/4″, weight 400 lbs.

Buffalo Armor Plate Tools



NO. 10 BAR CUTTER

HERE is a machine which weighs only 300 pounds, yet is as strong as a cast-iron machine of twice its weight. It is therefore highly desirable for school work as it can easily be moved around the shop. The frame consists of two heavy plates of Armor Plate Steel of 75,000 pounds tensile strength, which are rigidly bolted and riveted together, enclosing the working parts. The stripper on side prevents binding of the metal and the roller prevents the bars from dulling the knives.

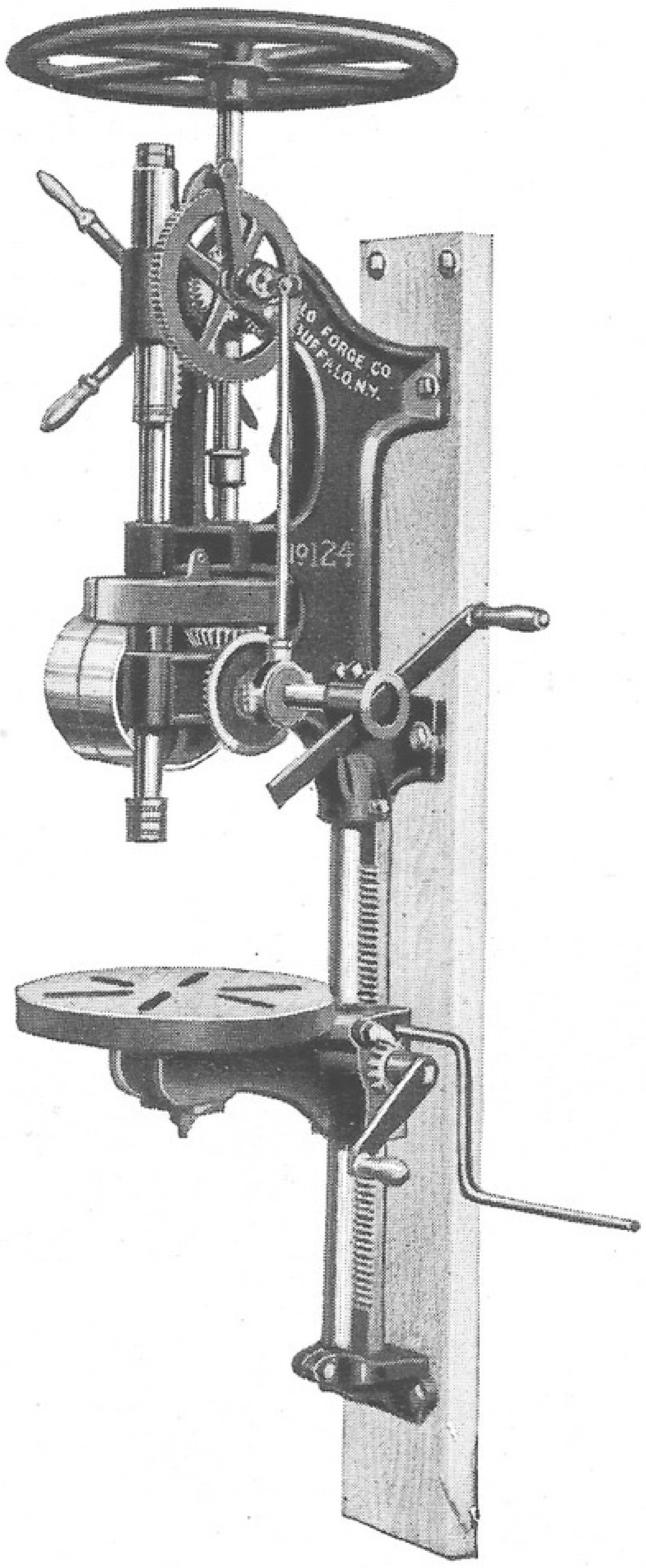
A treadle is provided for dropping the segment back into place after each cutting operation.

We can furnish this Bar Cutter mounted on wheels, or without legs for bench use. Two sets of knives are furnished for cutting light and heavy bars.

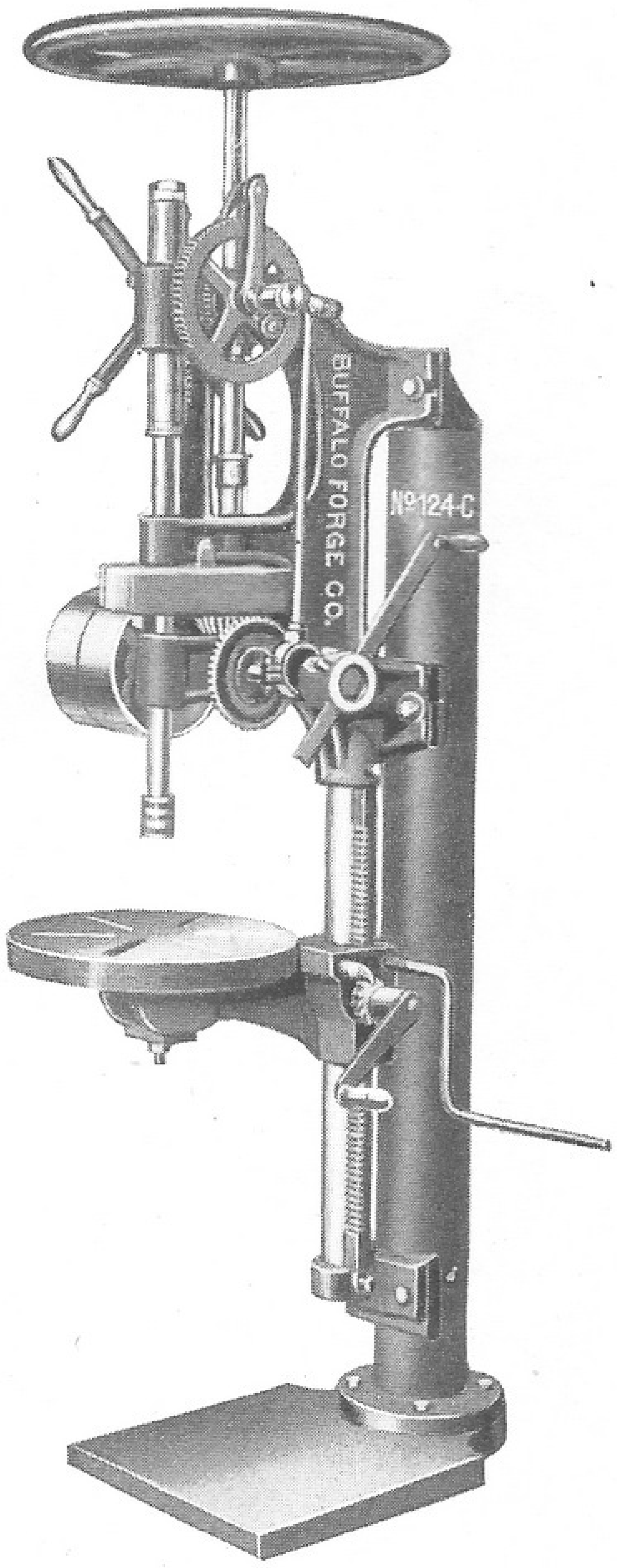
SPECIFICATION

No. 10 Buffalo Bar Cutter cuts Twisted Bars up to 1″. Cuts Round Bars up to 1⅛″. Shipping weight 315 lbs.

Buffalo Capstan Lever Drills



124A



124CA

Drills

FOR the Forge Shop the 124CA Buffalo Capstan Lever Drill is recommended. It is fitted with a Multi-Compound Lever Feed with which a 1″ hole can be readily drilled. This exclusive feature is obtained by the strong and simple rack on the feed head, operated by the four-arm lever.

A sliding collar is provided at feed head for changing from lever to automatic feed or the reverse. Another is at the lower end of the fly wheel shaft for changing from slow to high speed. Either change is made in a moment. The collar will slide regardless of position of key and seat itself automatically.

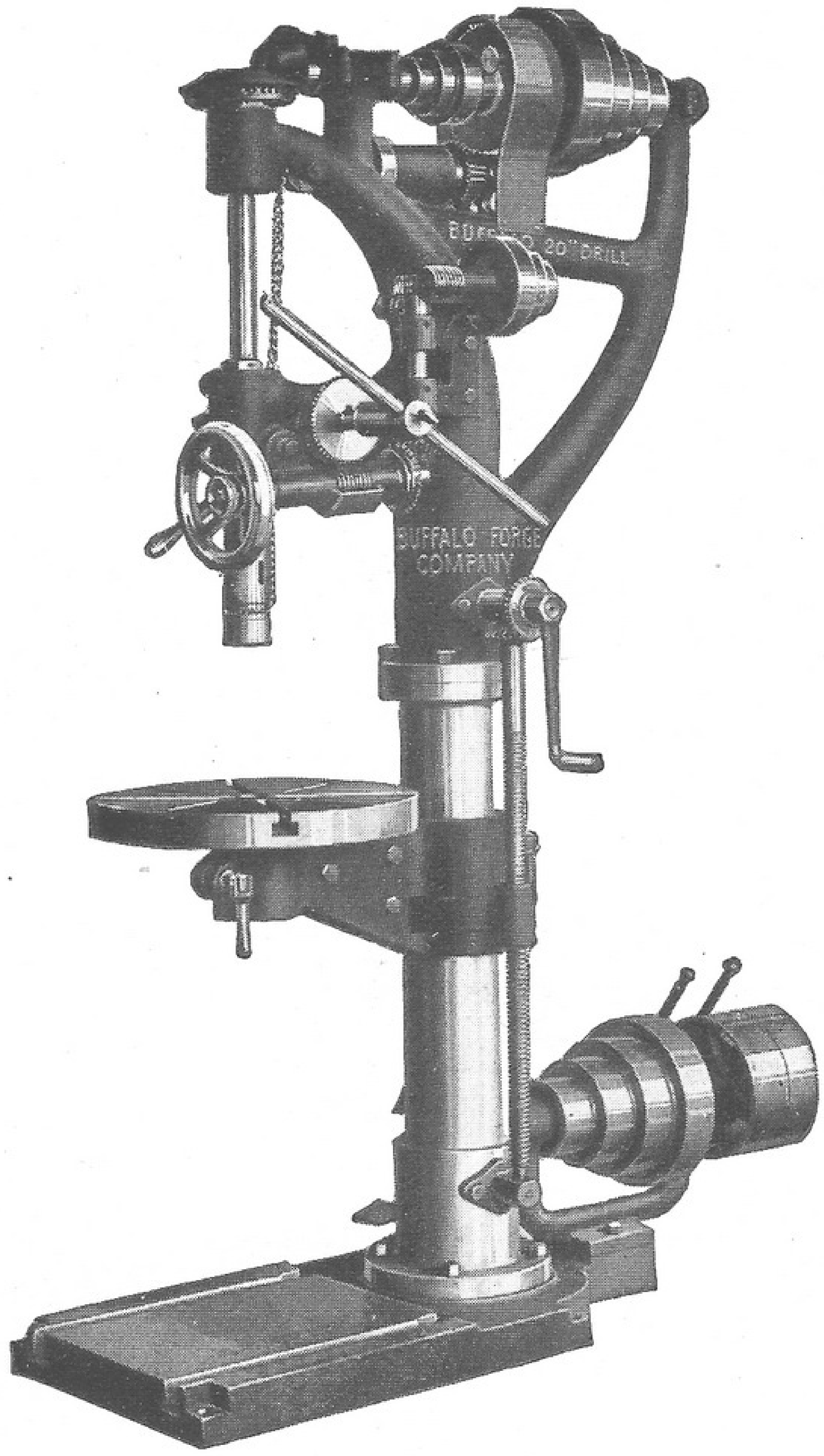
All gears are machine cut. The automatic feed is adjustable to four speeds. The drill is equipped with a quick return, eliminating the necessity of turning back the feed wheel after drilling. The table is adjusted by means of a crank conveniently located.

SPECIFICATION

Drills holes up to 1½″ diameter thru center of a 24″ circle. Run of feed 8″, run of table 20″, total height 78″, weight 610 lbs.

The above drill can be furnished direct connected to a ½ H. P. motor geared direct to the drill. This is recommended for the shop where comparatively heavy work is to be done.

Buffalo 20 Inch Drill



MADE IN FIVE STYLES AS FOLLOWS

No. 1—Plain Lever Feed.

No. 2—Hand and Lever Feed.

No. 3—Hand, Lever and Automatic Feed.

No. 4—Hand and Lever Feed with Back-Gears.

No. 5—Hand, Lever and Automatic Feed and Stop with Back-Gears

THE Buffalo 20″ Back-Geared Power Drill is recommended for the large forge shop where one drill will be used practically all the time. It will drill holes readily up to 1½″ in diameter. The spindle sleeve is graduated into ⅛″ divisions, each inch being numbered. The frictional handle which is adjustable for lengths from 9½″ to 18½″ may be used on either the right or left hand side of the drill. The table is lathe turned and has four "T" and four through slots for clamping bolts. It can be swung to either side, swiveled in its socket and locked. The table is raised or lowered by a crank and screw located on the right side of the column. The change from plain to back geared drive is accomplished by disengaging a small knob on the top of back gear and then throwing in the back gear by means of a hand lever. This drill gives 8 speeds and 3 power feeds, together with hand and lever feeds, and is suitable for all classes of drilling which would be encountered in school work.

SPECIFICATION

Height of Drill	74″
Drills to Center of	20″ Circle
Greatest Distance between Base and Spindle	41½″
Greatest Distance between Table and Spindle	25½″
Travel of Spindle	8½″
Diameter of Spindle in Sleeve	1⅜″
Spindle is bored for No. 3 Morse Taper	
Diameter of Spindle above Sleeve	1¼″
Diameter of Table	15½″
Diameter of Column	5½″
Size of Tight and Loose Pulley	8 x 3″
Speed of Drive Pulleys	300 R.P.M.
Diameter of Crown Gear	5⅝″
Smallest Diameter of Cone Pulley	4″
Largest Diameter of Cone Pulley	9″
Width of Cone Pulley Steps	2⅛″

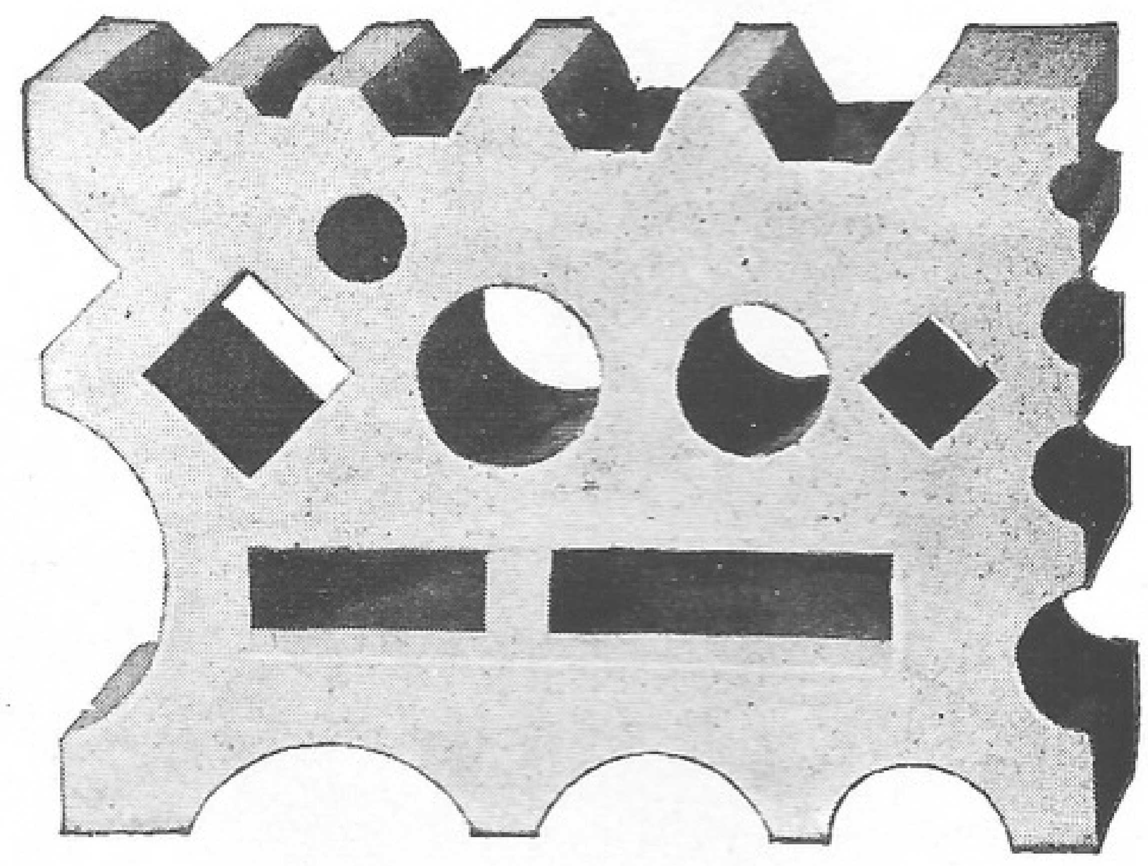
Forge-Shop Tools

Anvils and Blocks

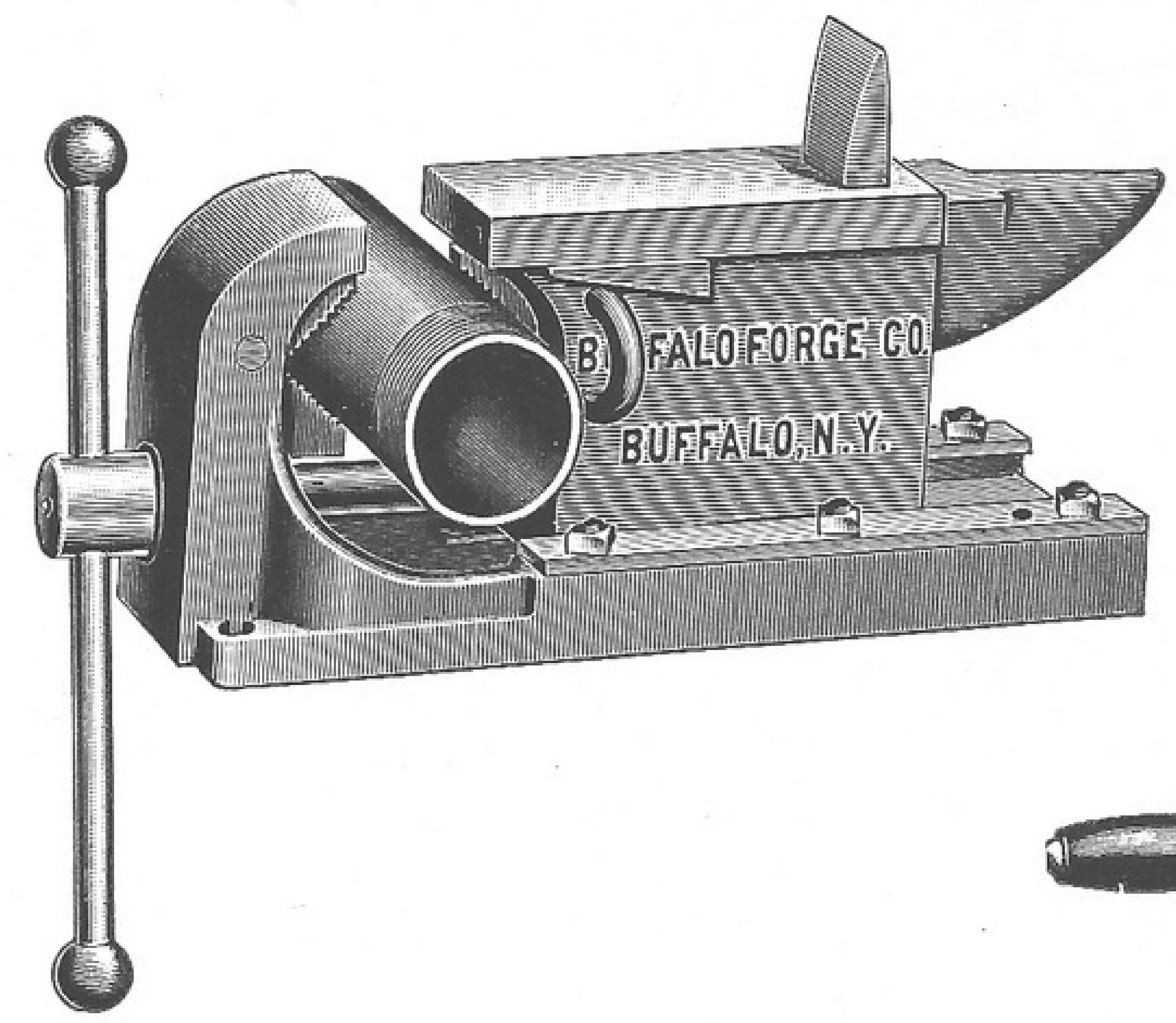
In addition to a complete set of blacksmith tools which we are now offering, we manufacture a complete line of semi-steel anvils in sizes varying from 50 to 150 lbs., and also cast-iron anvil blocks suitable for the various size anvils. These semi-steel anvils are considerably cheaper than regular steel anvils and are entirely suitable for such light work as is usually done in a Manual Training Forge Shop, but when preferred we can furnish a steel anvil of any standard manufacture.

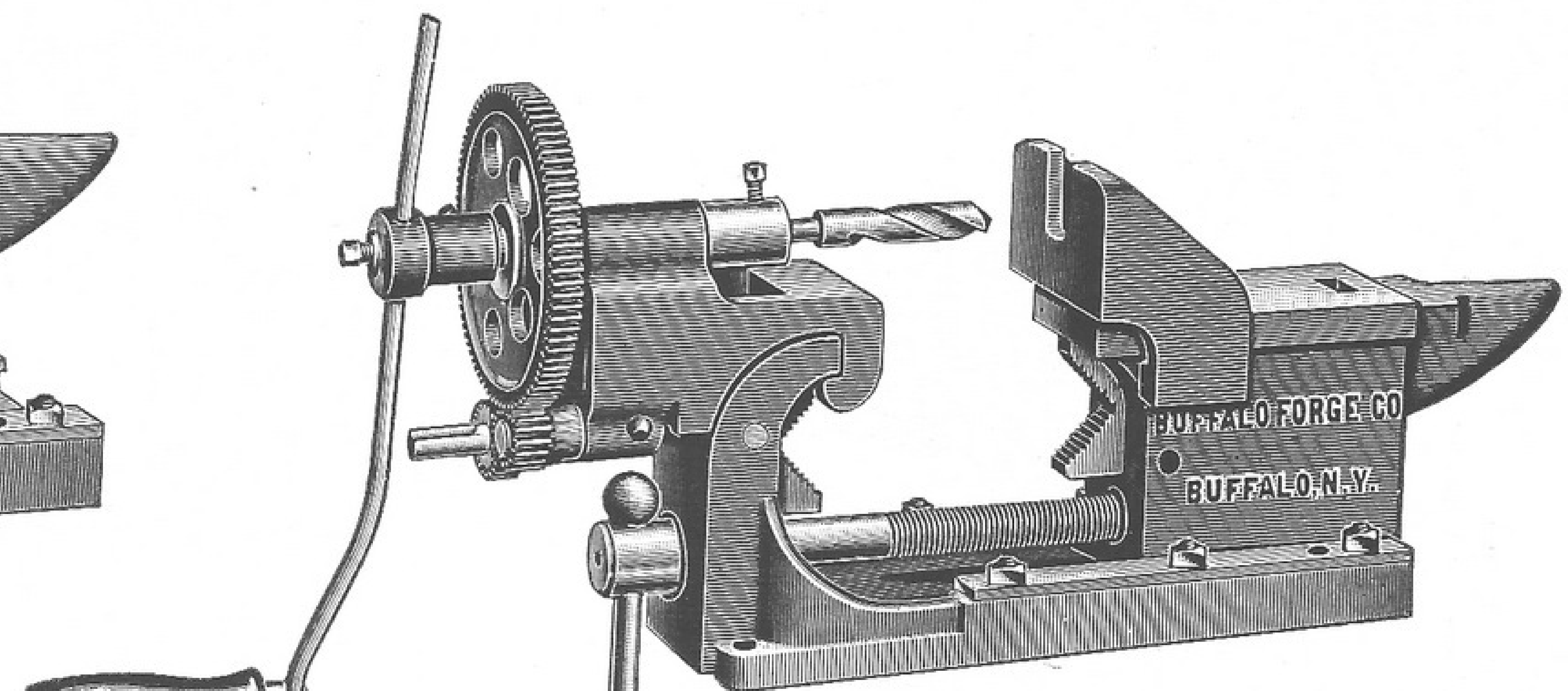
Swage Blocks

We can now furnish Swage Blocks in various sizes made of cast-iron. Most any shape desired can be had, round, square or hexagonal. Every school equipped with anvils should also have a Swage Block as they are almost indispensable when a variety of work is taught. They also save the purchase of special tools.



Buffalo Combination Vise



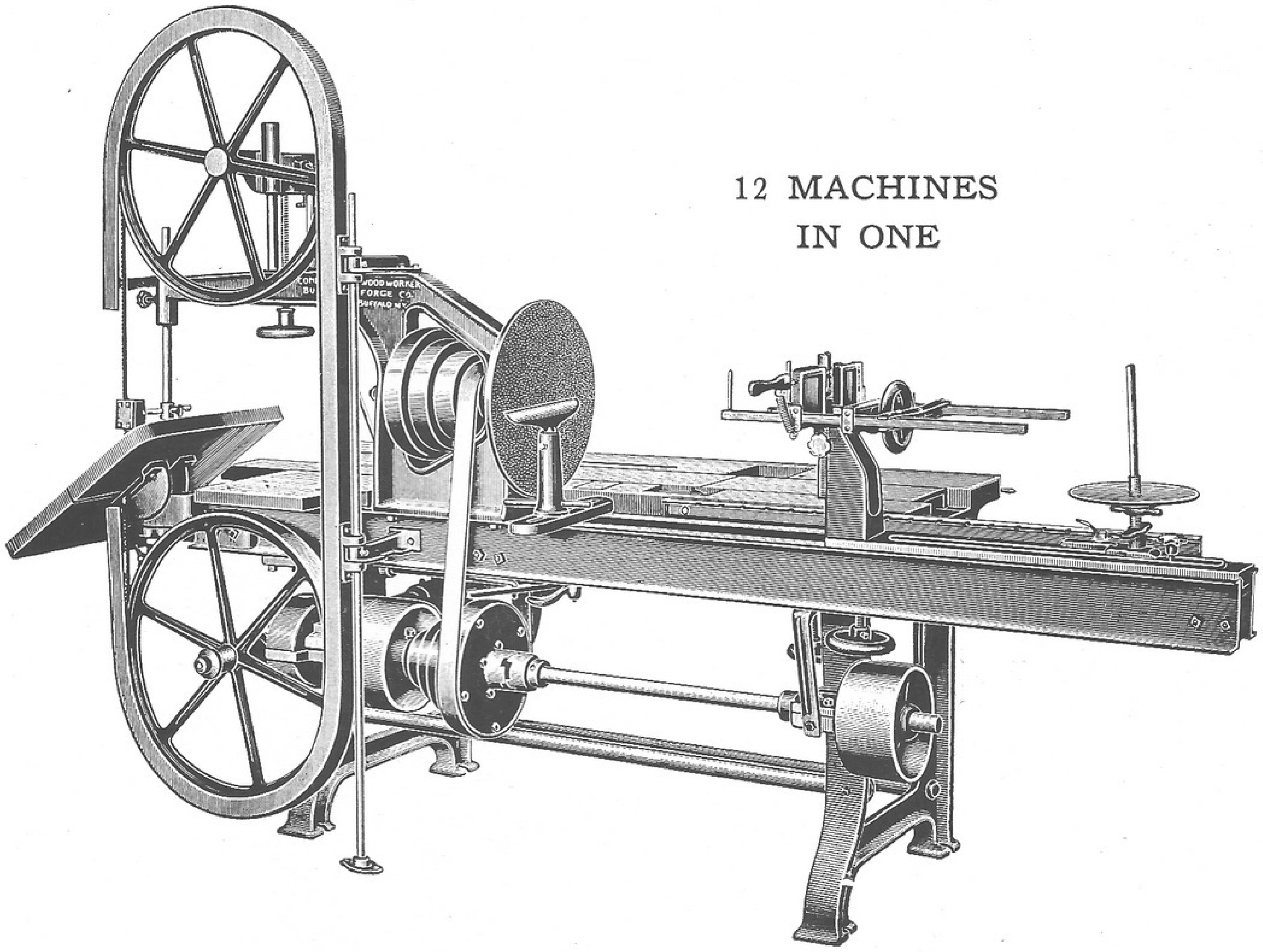


Included in this one Combination is an Anvil, Anvil-vise, Pipe-vise, and Drill-press. The face of the anvil is 3″ x 8″. Pipe jaws are removable and will grip pipe from ⅛″ to 3″ in diameter.

(Note please that this is the only combination made that will take this wide range of pipe with the same set of pipe jaws.)

All parts are quickly assembled making a useful and efficient tool. Weight 60 lbs.

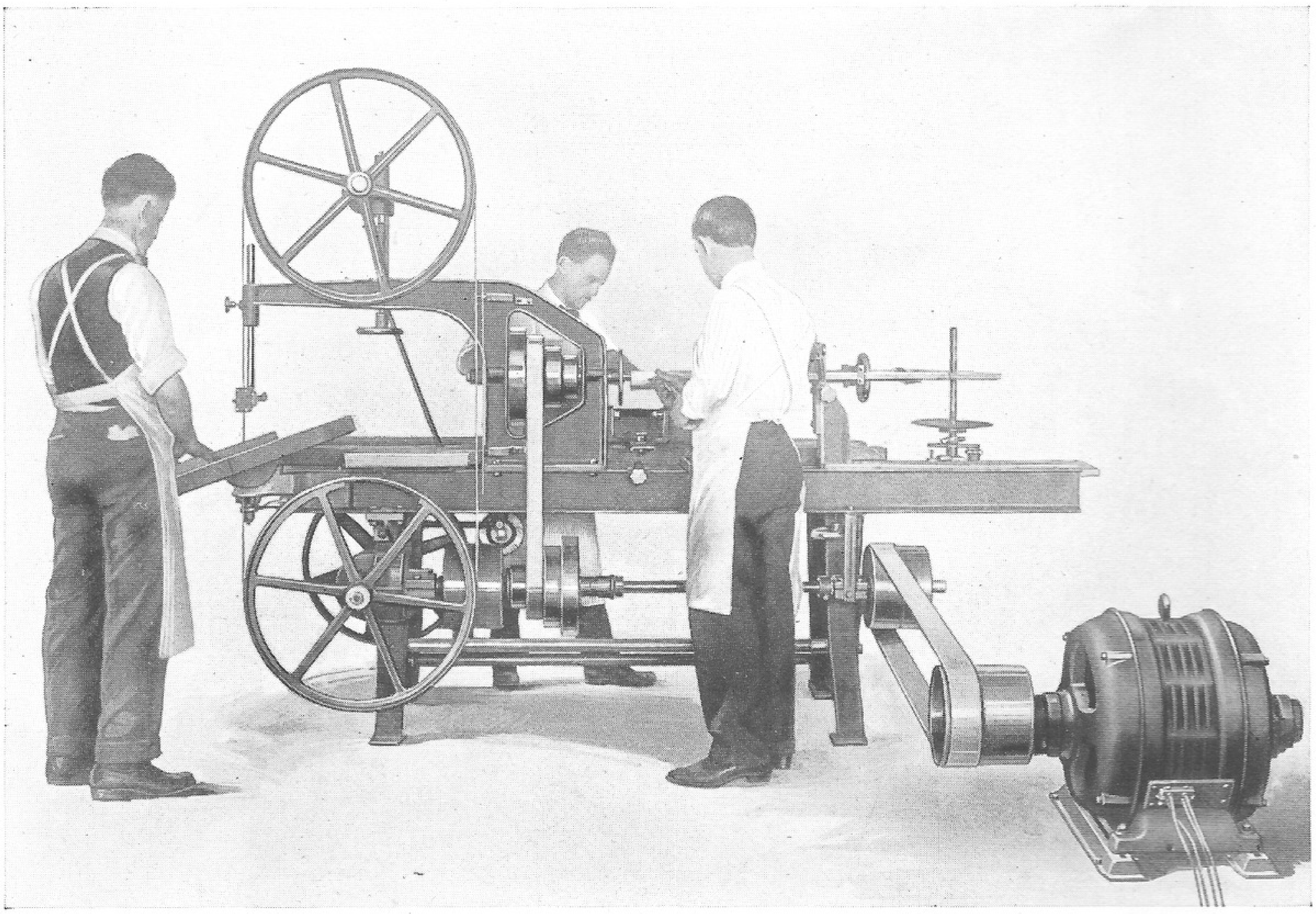
Buffalo Complete Woodworker



12 MACHINES
IN ONE

EVERY Manual Training School where any woodwork whatsoever is done should be equipped with the Buffalo Complete Woodworker. In addition to having combined 12 machines into one, the design is such that three students may do separate work on the machine at one time. It is equipped with tight and loose pulleys so that it may be driven from a line shaft, or from an individual motor or gasoline engine. All parts may be run at one time or separately. The lathe may also be used for boring, tenoning, drilling, sanding, and may be equipped with a grinder for sharpening tools. The band saw may be operated entirely separate from the lathe. The arbor may be used as a circular saw, a planer, a jointer, and a shaper. Each of these parts are engaged or disengaged by means of conveniently located clutches. The main drive may be controlled from either side of the machine by means of lever and belt shifter. The maximum power required to operate all machines at one time is 5 H. P. The size of the main pulley is 10″ diameter, 3½″ face. The diameter of the drive shaft is 1⅜″.

Buffalo Complete Woodworker

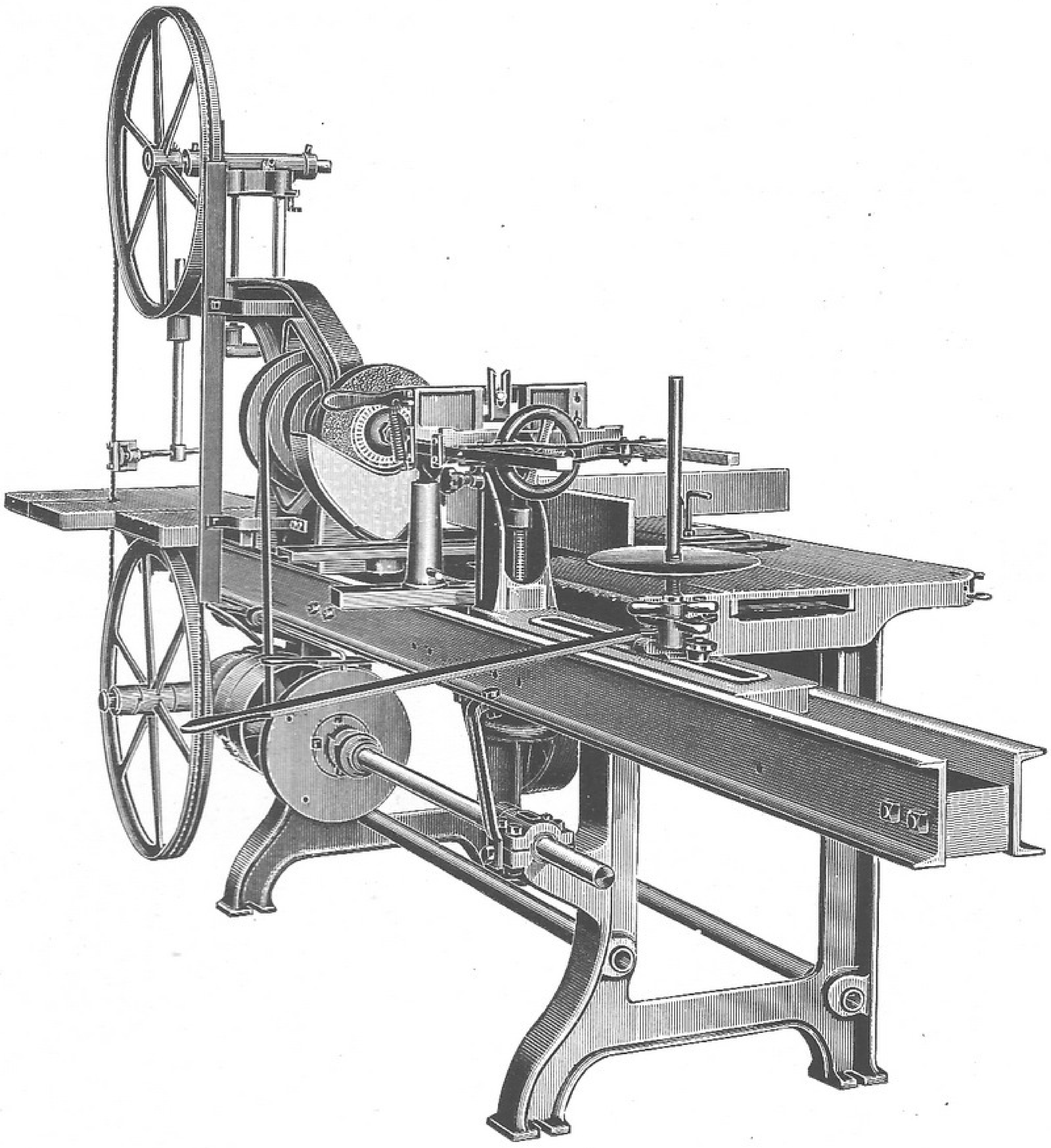


BELTED TO AN ELECTRIC MOTOR

THIS machine is the result of 10 years' manufacture of previous models and is entirely practical—there is no skimping as regards weight and capacities.

In building a machine of this character, where it is desired to include a number of features on one base, some manufacturers in their anxiety to combine the different units do not stop to consider the life of the machine as a whole, their only aim being to increase capacity rather than practicability or efficiency.

Buffalo Complete Woodworker



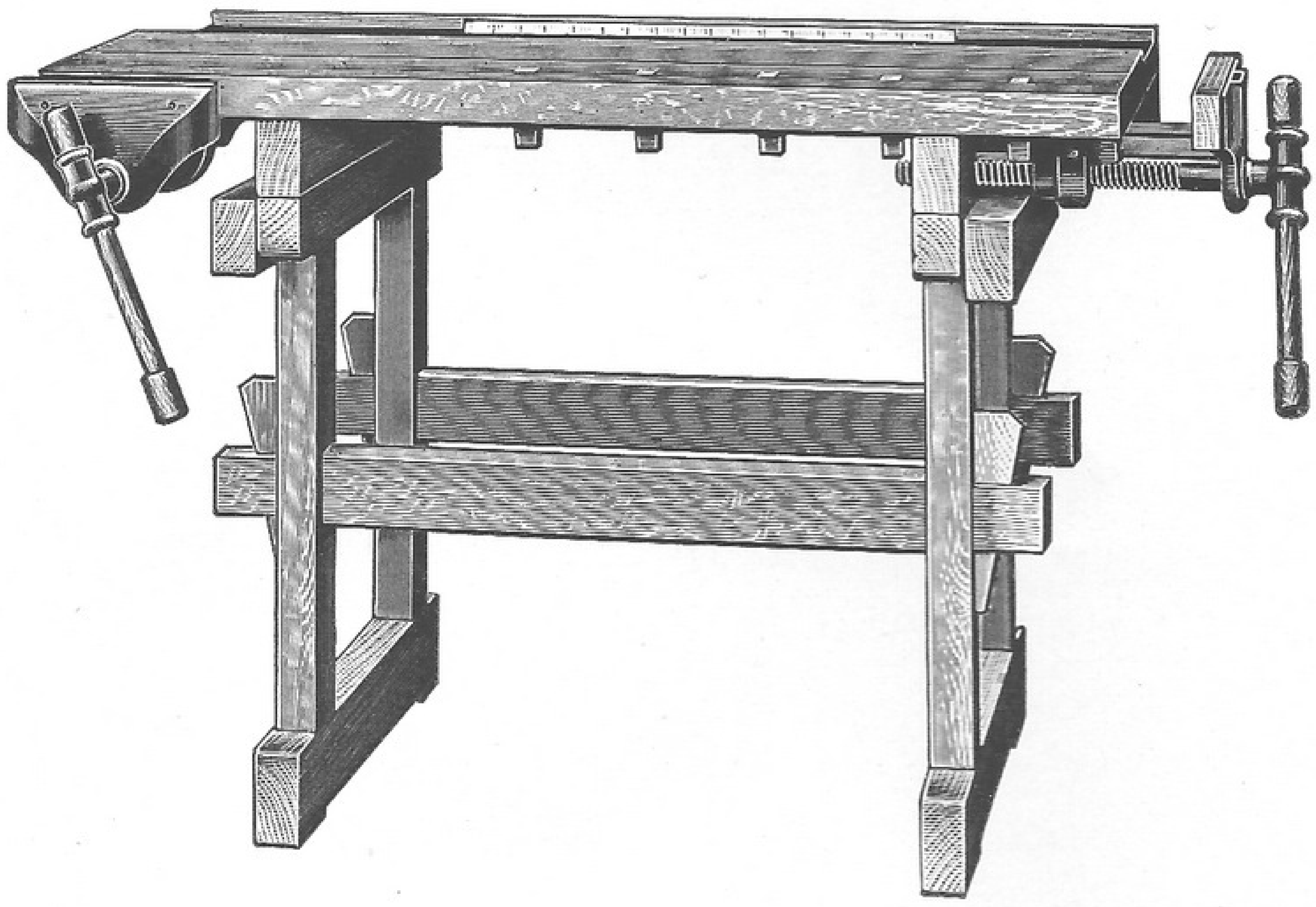
VIEW FROM WHEEL-HOLDER END SHOWING THE LATHE SIDE OF THE "BUFFALO"

SPECIFICATION

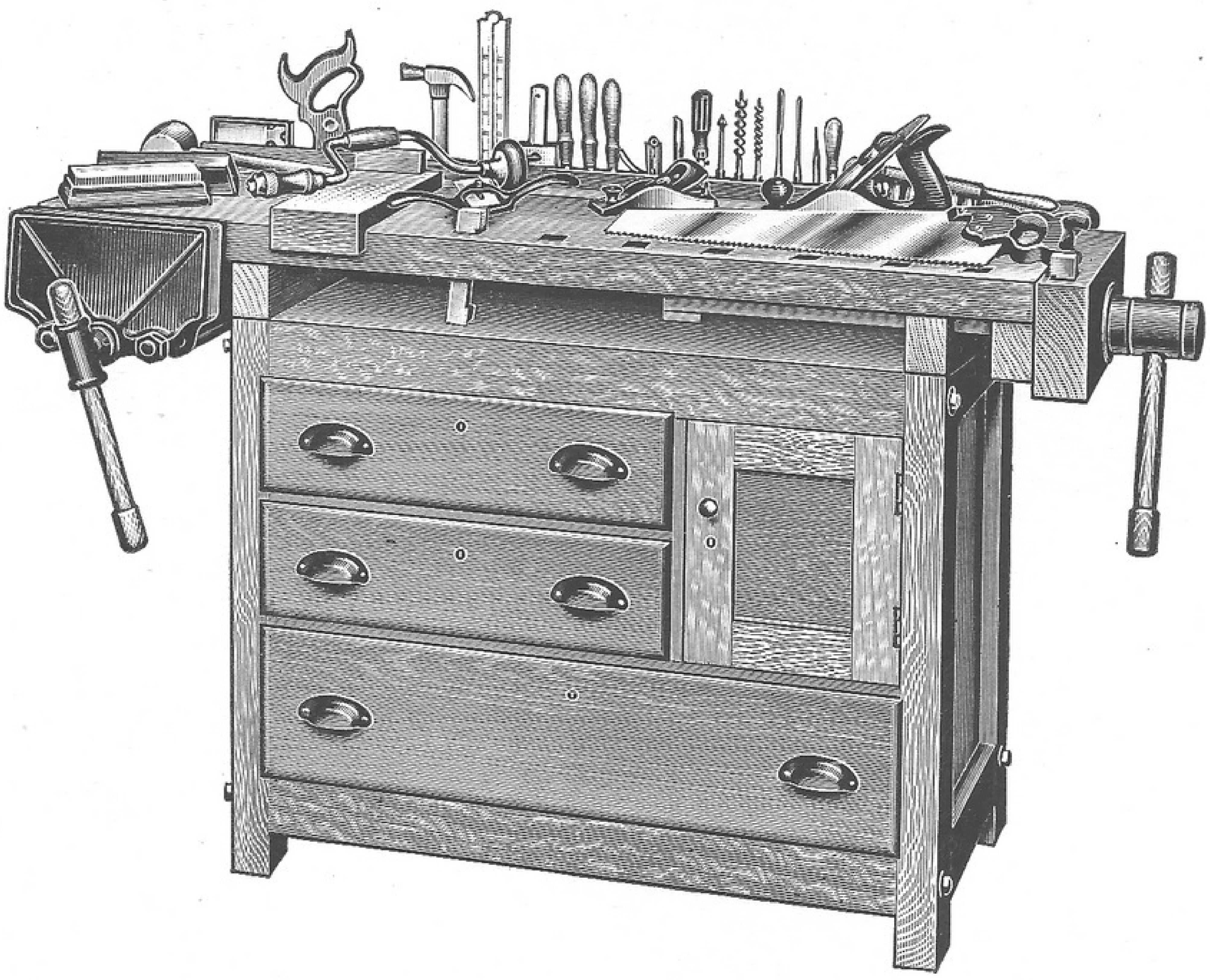
The Buffalo Complete Woodworker is equipped with iron table and planer mandrel. The overall length of the table is 6′ 6″ x 4′ 4″. Height of top 35″. Greatest overall length with spoke equalizer and carriage pulled out, 14′. Weight 2150 lbs. Diameter of drive shaft 1⅜″. Size of tight and loose pulleys on drive shaft 10″ diameter, 3½″ face.

Work Benches

Single Bench No. 1



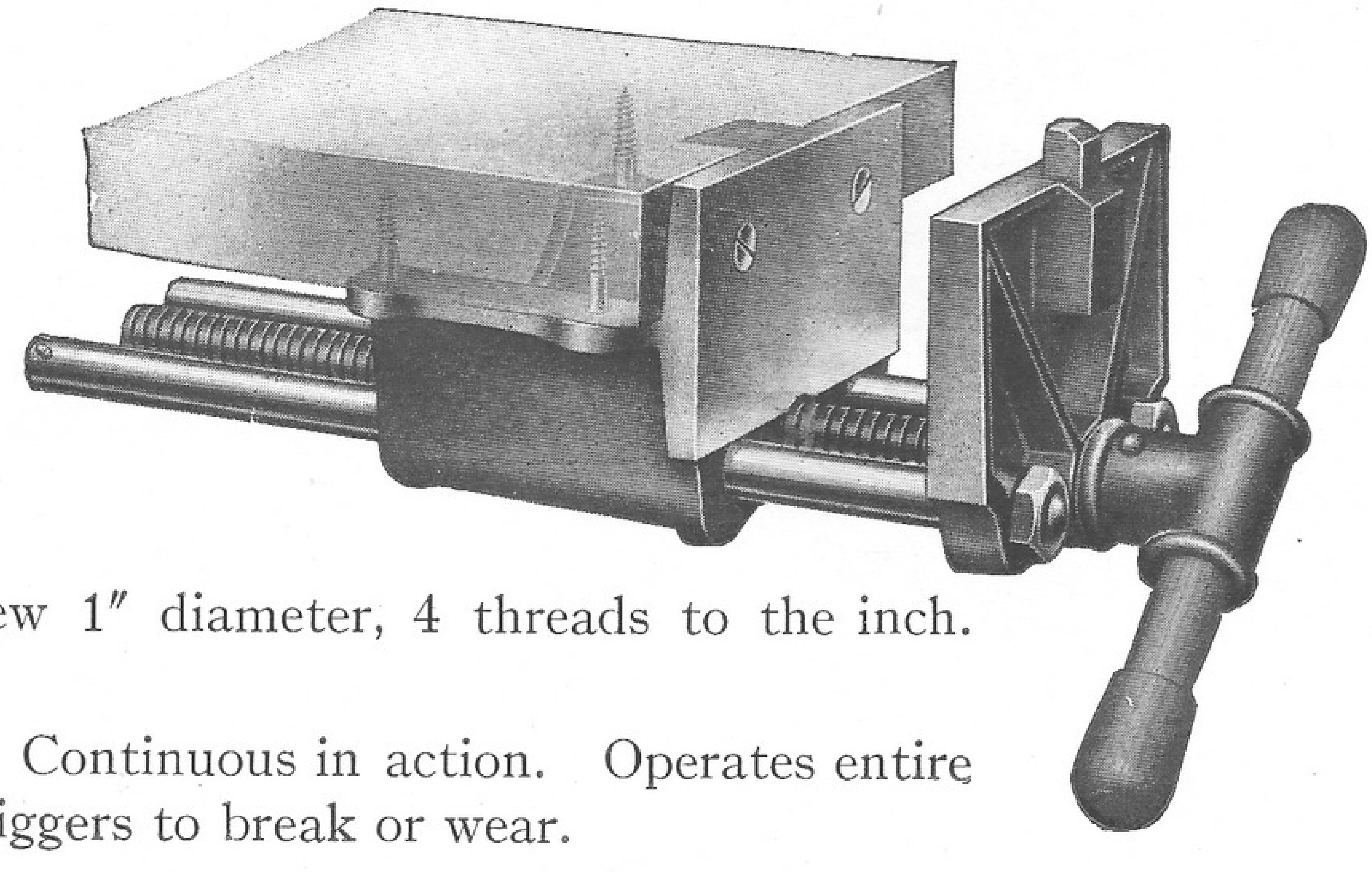
Made entirely of hard maple. Top is made of 2½″ strips, glued together to prevent warping. Frame is doweled and bolted, making it exceedingly rigid. Has 2 vises which are equipped with 2″ wood bench screws. Size of top 40″ x 20″ x 2″. Extreme dimensions, including vises, 54″ long, 26″ wide, 31″ high.



Single Bench No. 142

This bench is fitted with drawers and cupboard affording ample room to keep tools, material and finished articles. The top is the same as No. 1, illustrated above. The stand is 30″ high, 30″ wide and 20″ deep. The drawers are 16¾″ x 18″ x 5¼″. The cupboard is 18″ high, 9″ wide and 18″ deep. The entire bench is made of maple. The cabinet is varnished and the top oiled.

Rapid Acting Vise



No. 1. Jaws 7″ wide, 4″ deep, open 10″; screw 1″ diameter, 4 threads to the inch. Weight 32 lbs.

No. 2. Jaws 10″ wide, 5″ deep, open 12″; screw 1″ diameter, 4 threads to the inch. Weight 42 lbs.

Instantaneous adjustment. Continuous in action. Operates entire length. No pawls, racks or triggers to break or wear.

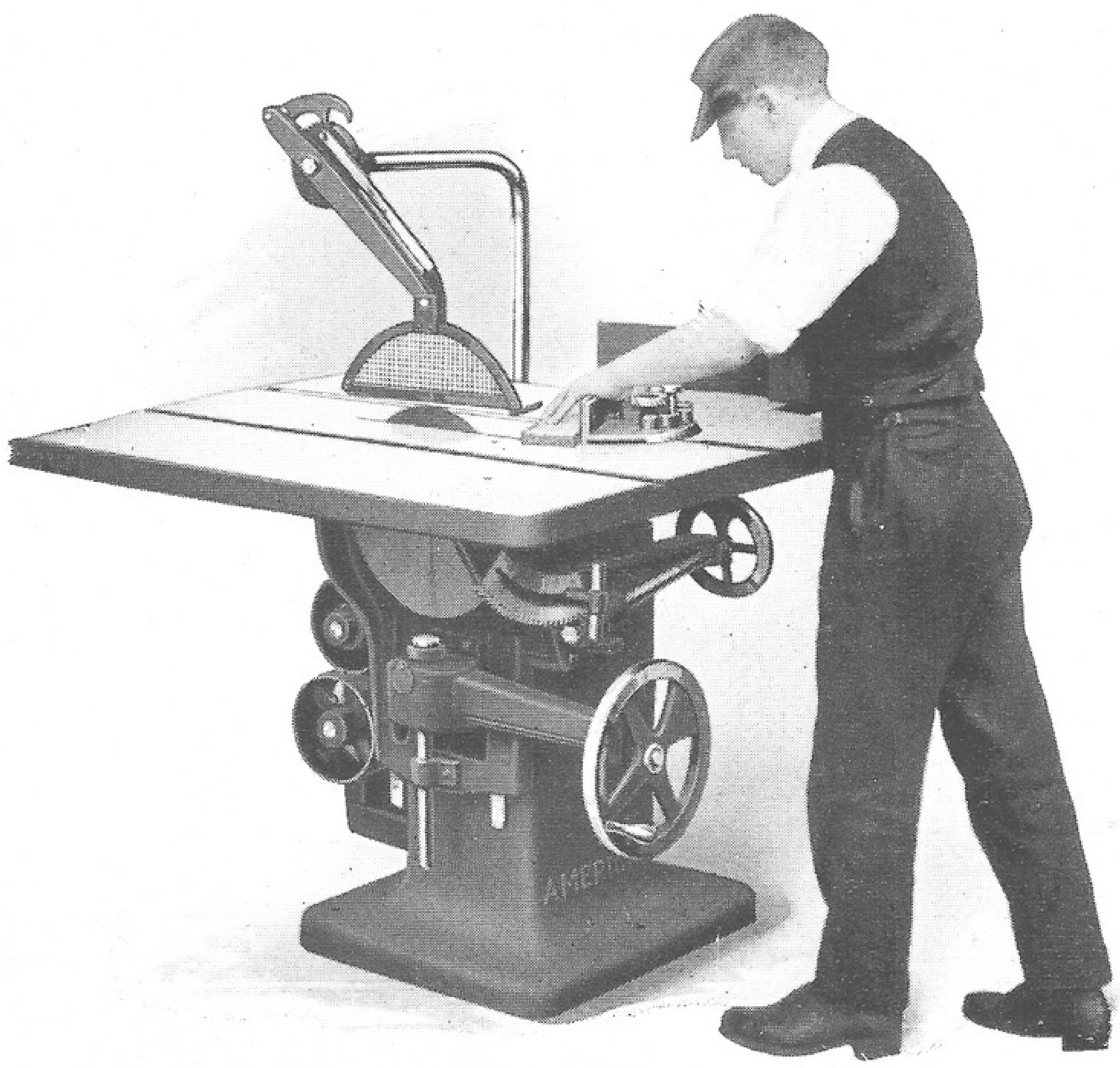
Woodworking Machinery

Saw Bench with Adjustable Saw Guard

This machine rips or cross-cuts without changing knives.

It will rip material 22½″ wide and cross-cut 24″. Saws up to 14″ diameter may be used. The table tilts (as shown below) to 45° for bevel work.

One combination rip and cross-cut saw is furnished with the machine.



ADJUSTABLE SAW GUARD
AMERICAN PRECISION SAW BENCH

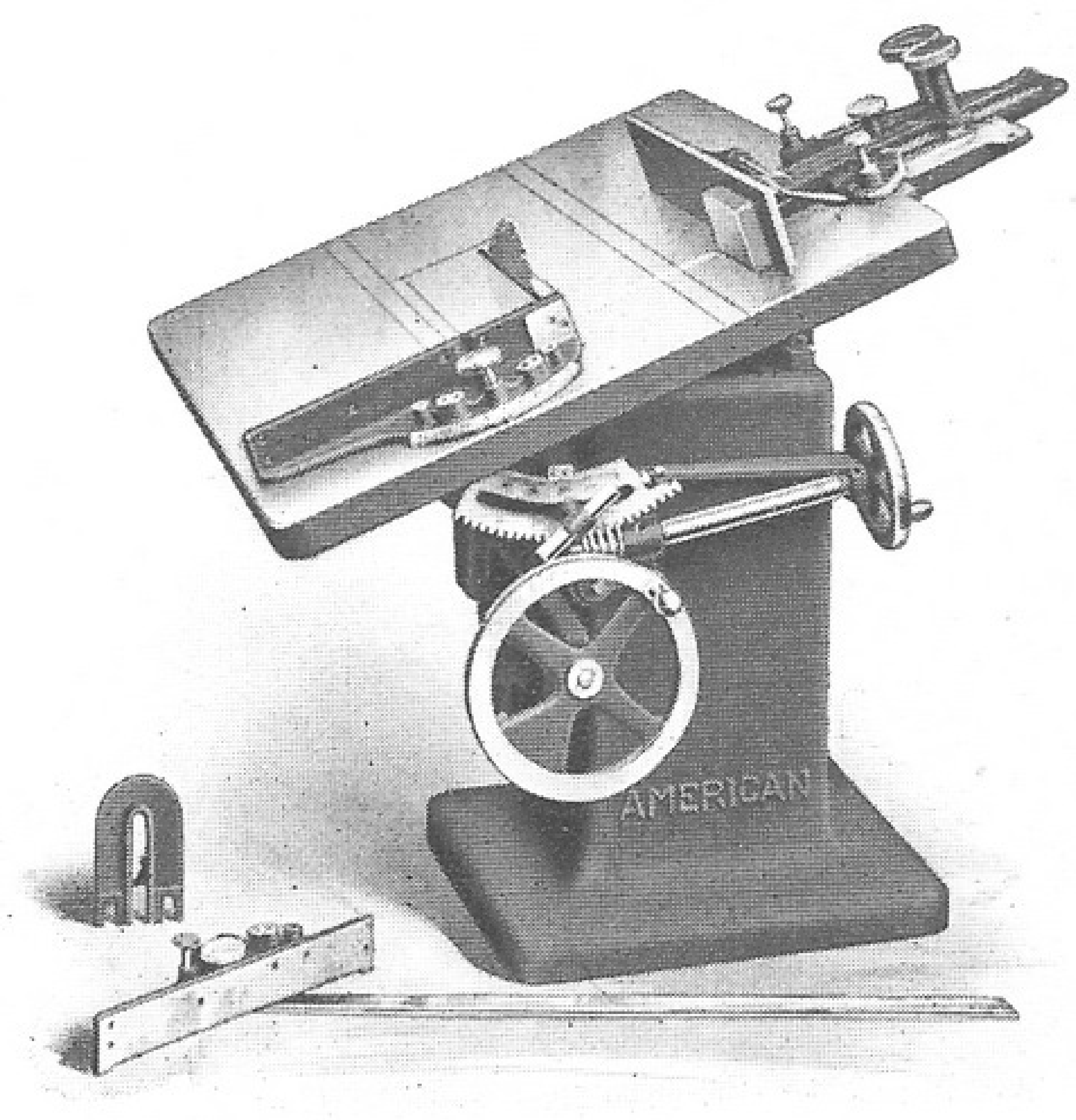


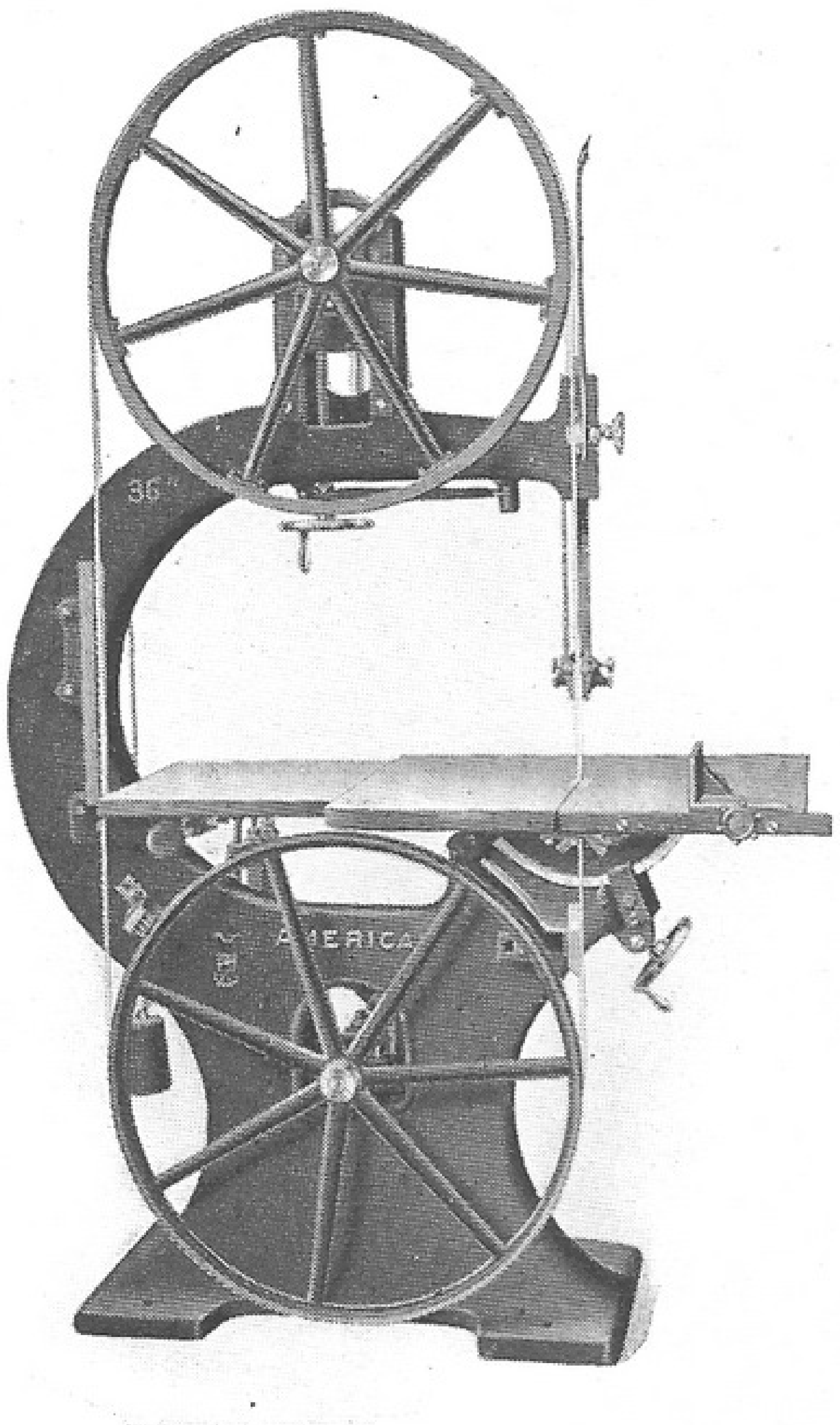
TABLE TILTED

The table is made of iron, 36″ x 44″. Adjusts vertically 5″ on gibbed ways by hand wheel and screw. Has detachable throat plate around the saw blade, which may be removed when heads are to be used on the arbor.

The arbor is 1½″ in diameter and journaled in ball bearings. Pulley is 3½″ x 5¼″ and has cork contact for belt. Hole in saw is usually 1″.

Floor space, 3′ 6″ x 7′.
Horse Power, 4 to 7½.
Weight, 1000 lbs.

Woodworking Machinery



PLAIN MACHINE

36-Inch Band Saw

Here we illustrate the most perfect and efficient Band Saw made.

Possibility of accident eliminated by wire guard for upper wheel and the closed door for the lower one.

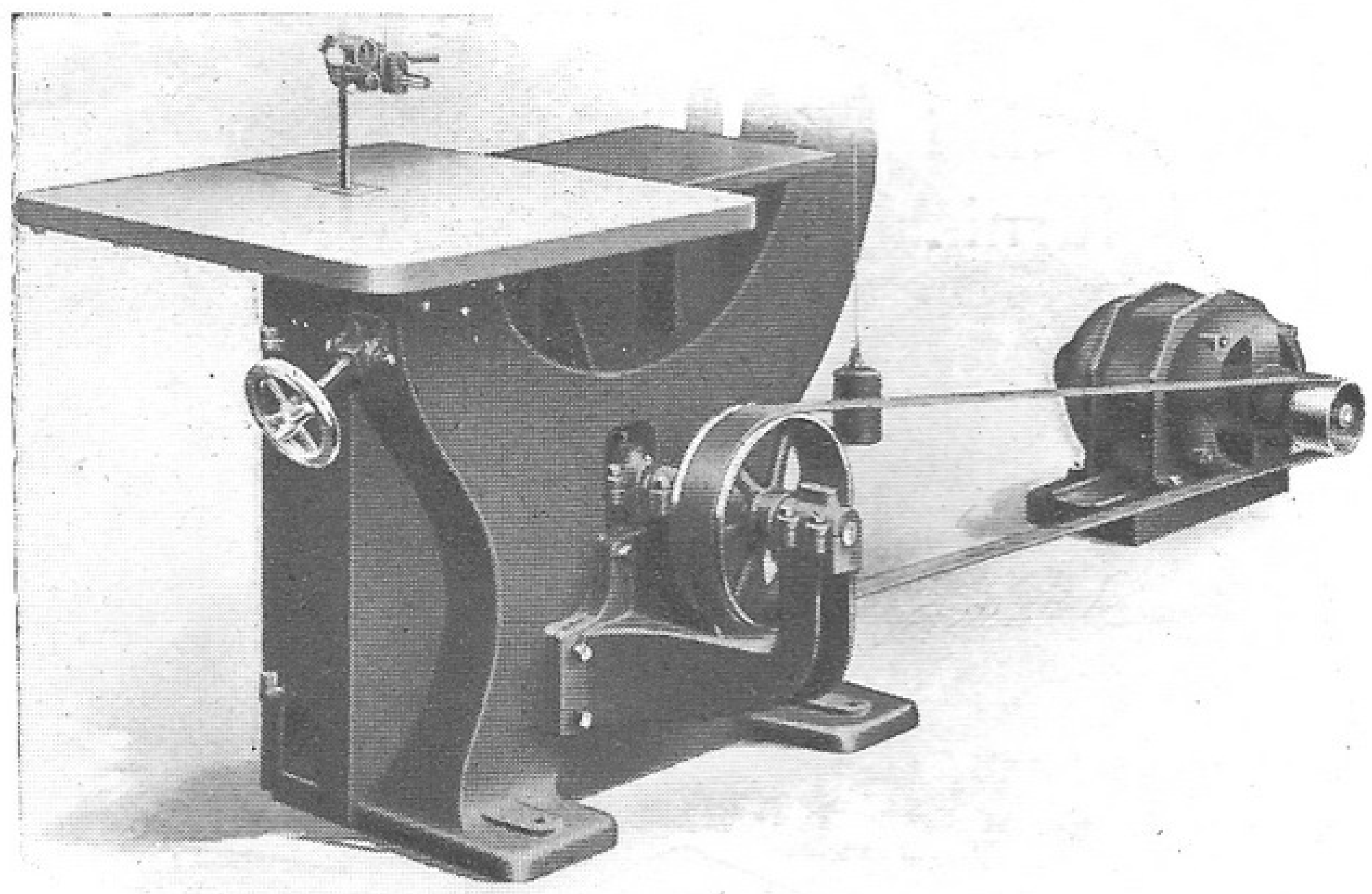
Remarkably easy running due to ball bearings of most approved type.

Direct-connected motor with rheostat mounted on the machine itself provides a highly efficient method of driving a Band Saw.

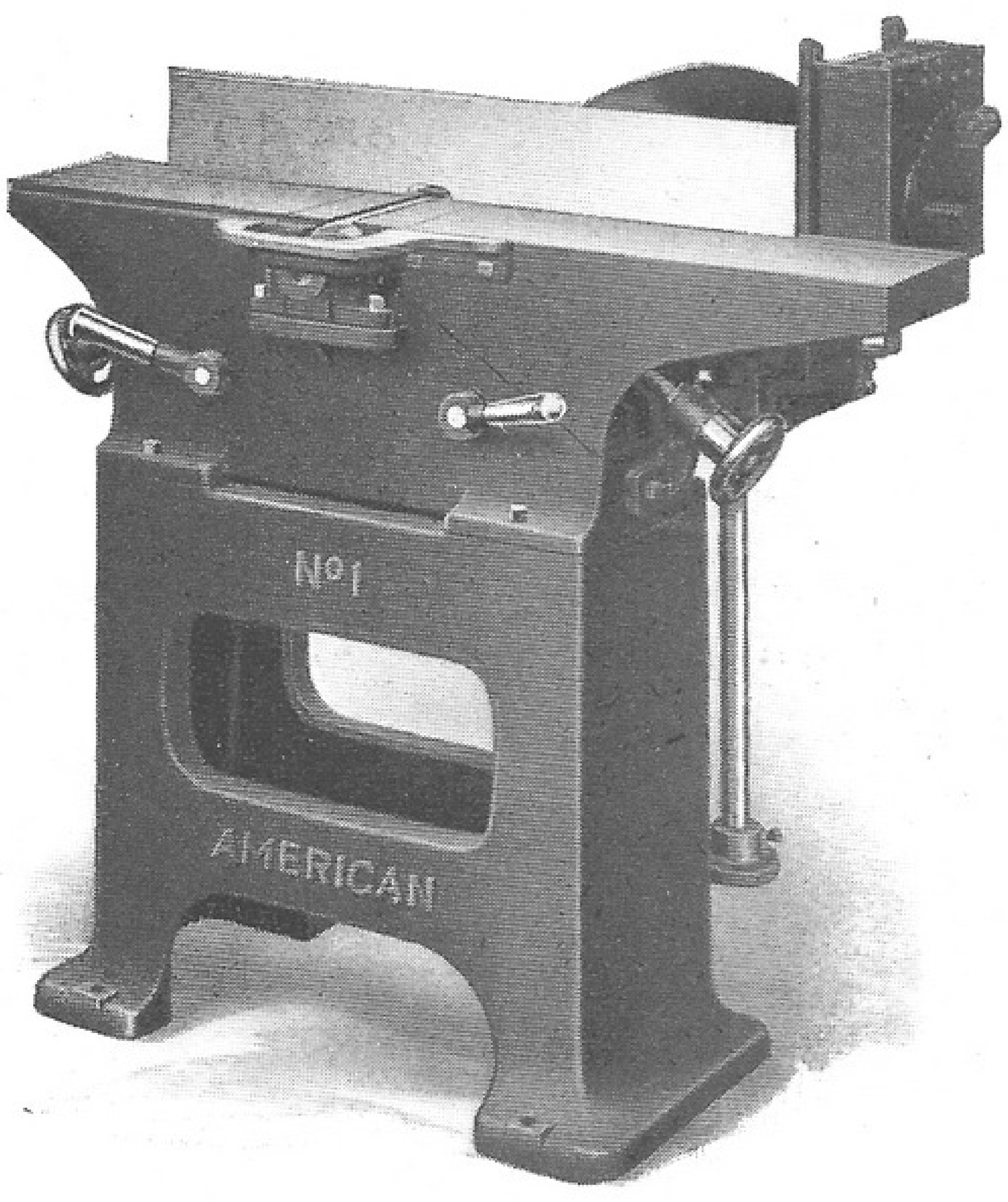
The table is 32″ x 32″, of iron and tilts 5° to the left and 45° to the right. Tilting device is indexed and self-locking.

Equipment included one saw ½″ wide by 19′ 3″ long, brazed, filed and set ready for use. Necessary wrenches.

Floor space, 3′ 6″ x 5′ 2″.
Horse power, 2 to 4.
Weight, 1300 lbs.



BELT DRIVE



AMERICAN NO. 1 BENCH JOINTER

Bench Hand Jointer

Improved safety type, with two thin knives held with clamping blocks in longitudinal slots.

Tables are one piece castings with long inclined ways, and they are clamped down securely to the bed by hand levers shown at the side of the machine.

Floor space, 41″ x 18″.
Horse power, 1.
Weight, 300 lbs.

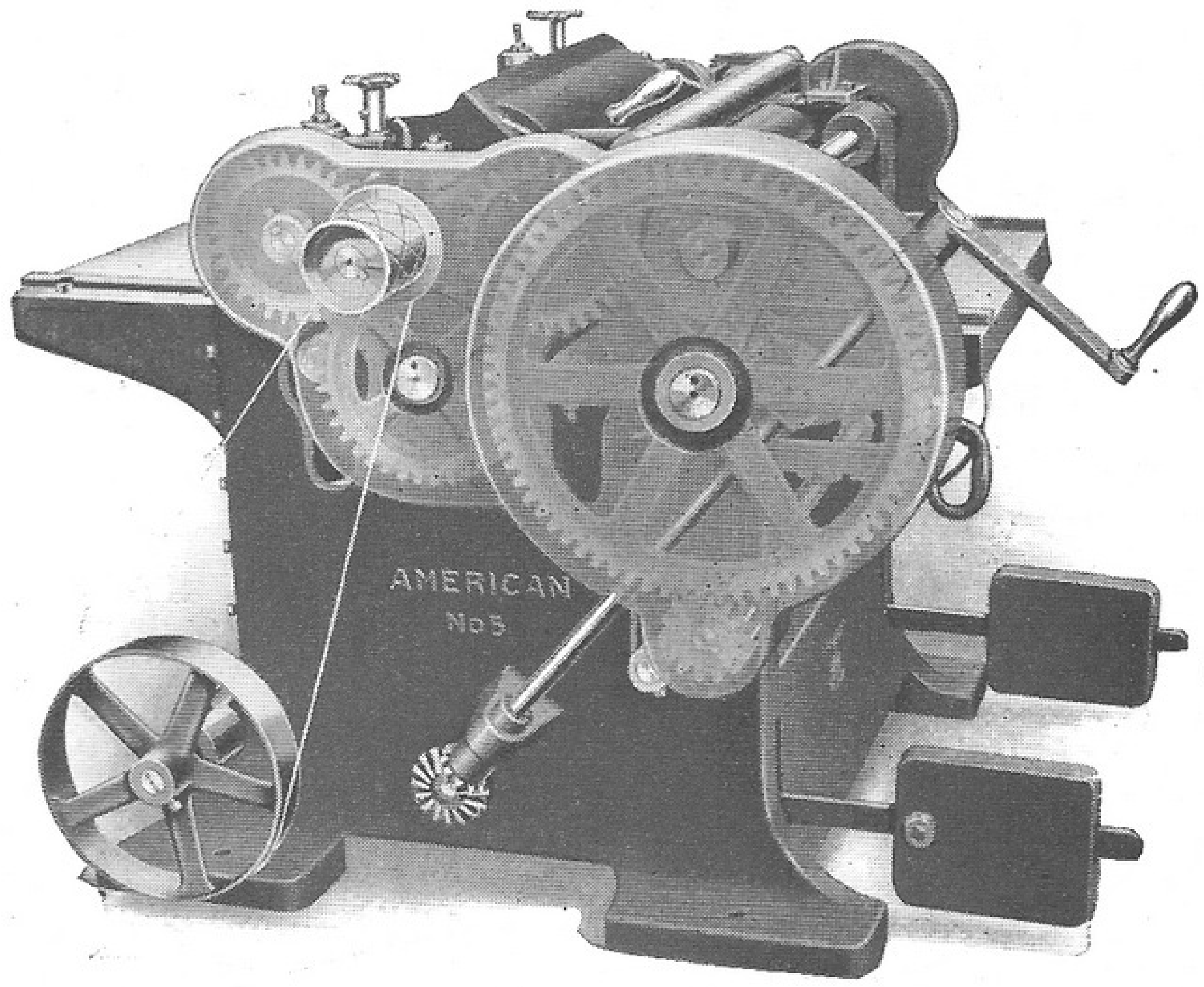
Woodworking Machinery

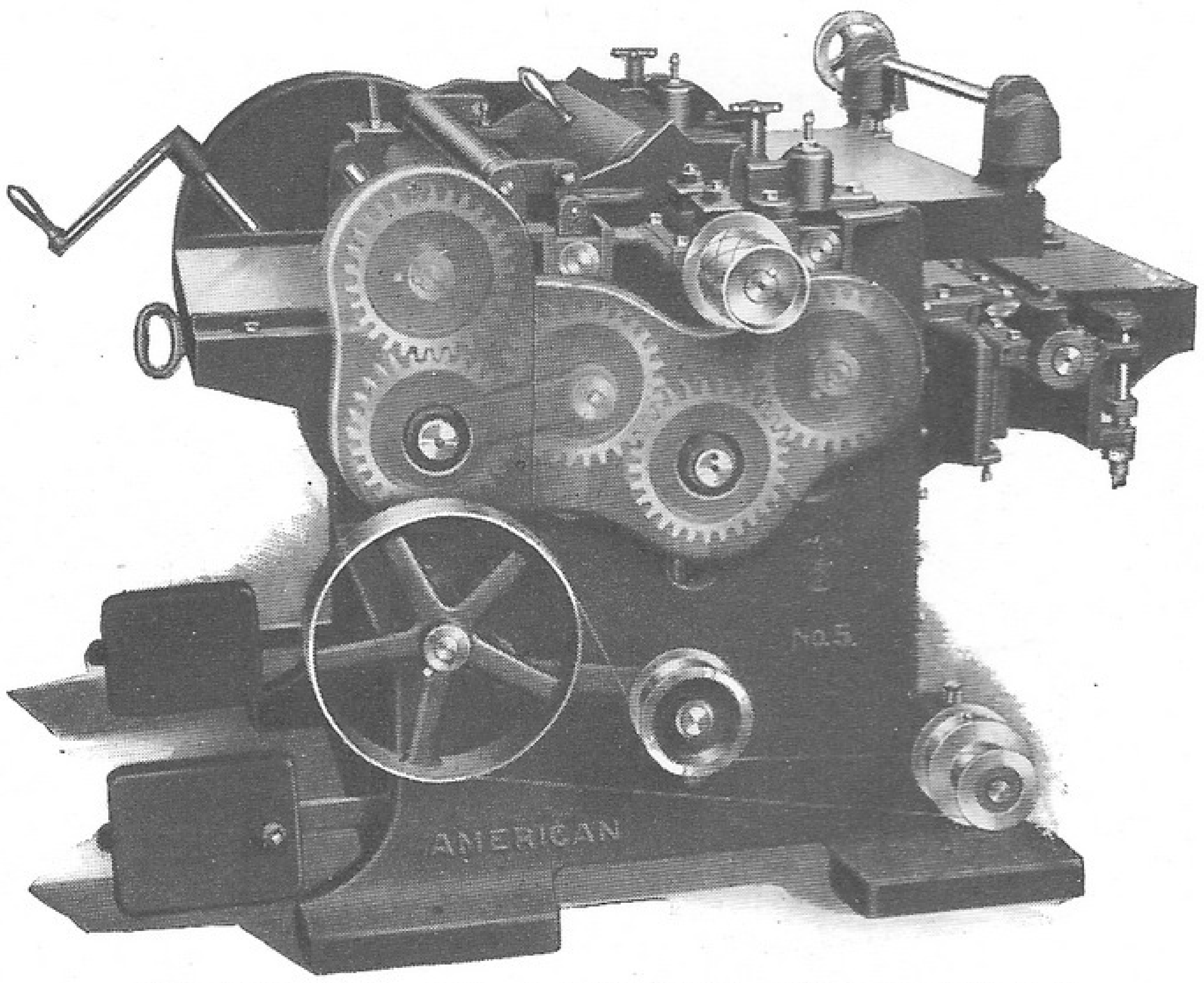
Single and Double Surfacers

Designed for fine cabinet work in hard or soft wood.

The bed is planed and scraped the whole length and adjusts on inclines and the feed is exceptionally powerful.

Will surface up to 24″ in width and to 8″ in thickness.





AMERICAN, NO. 5 SINGLE AND DOUBLE SURFACERS

SPECIFICATION

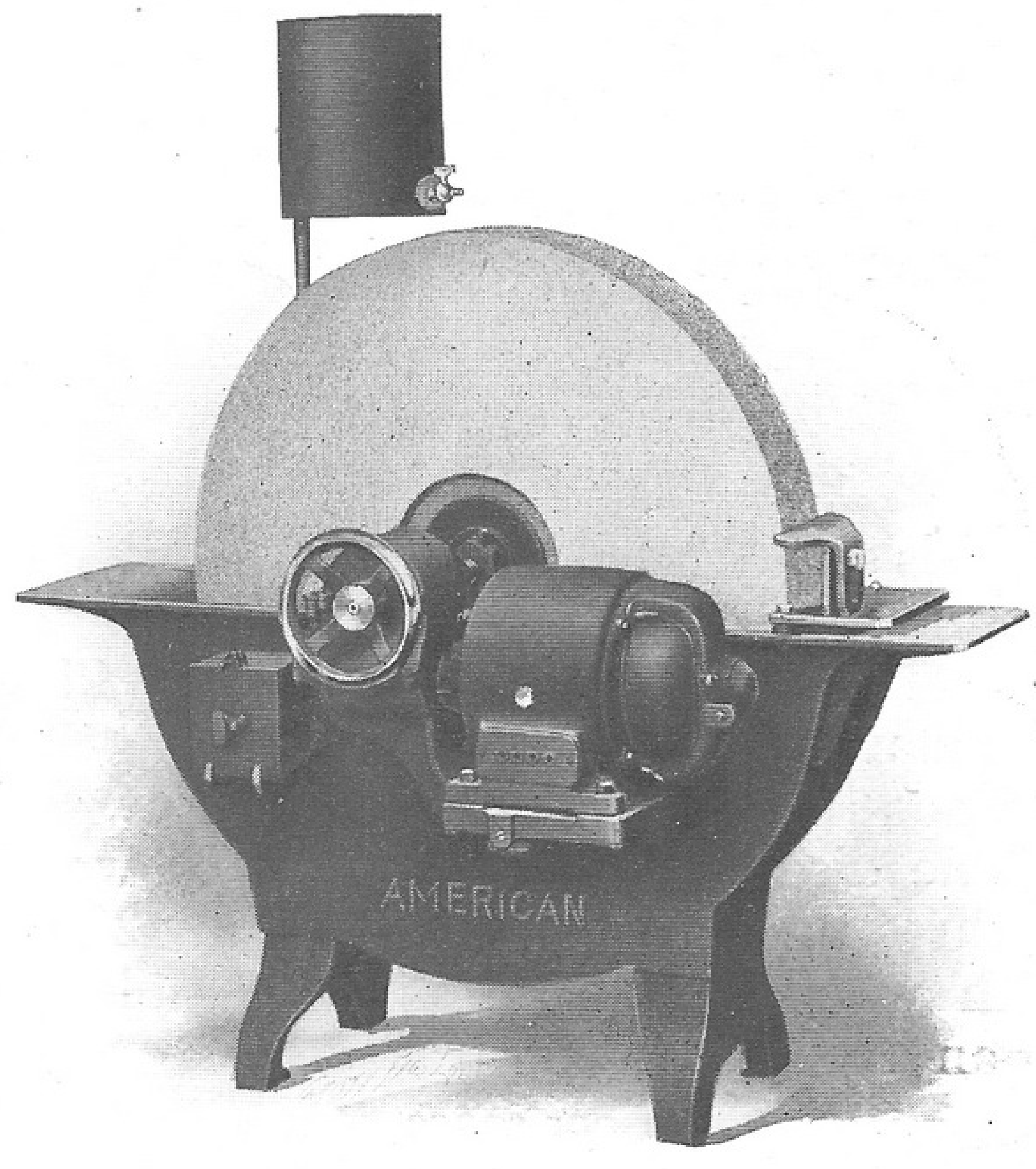
Floor space—double or single style, 5′ 4″ x 4′ 11″.
Horse power—Single, 5 to 10.
Horse power—Double, 7½ to 15.
Weight—Single, 2700 lbs.
Weight—Double, 2900 lbs.

Motor-Driven Grindstone

Substantially built. Fitted with Tool Rest and Water Tank.

Stone is of fine quality and is operated by gearing and electric motor.

Furnished in sizes from 30″ up to 48″ in diameter.



AMERICAN GRINDSTONE FRAME

Woodworking Machinery

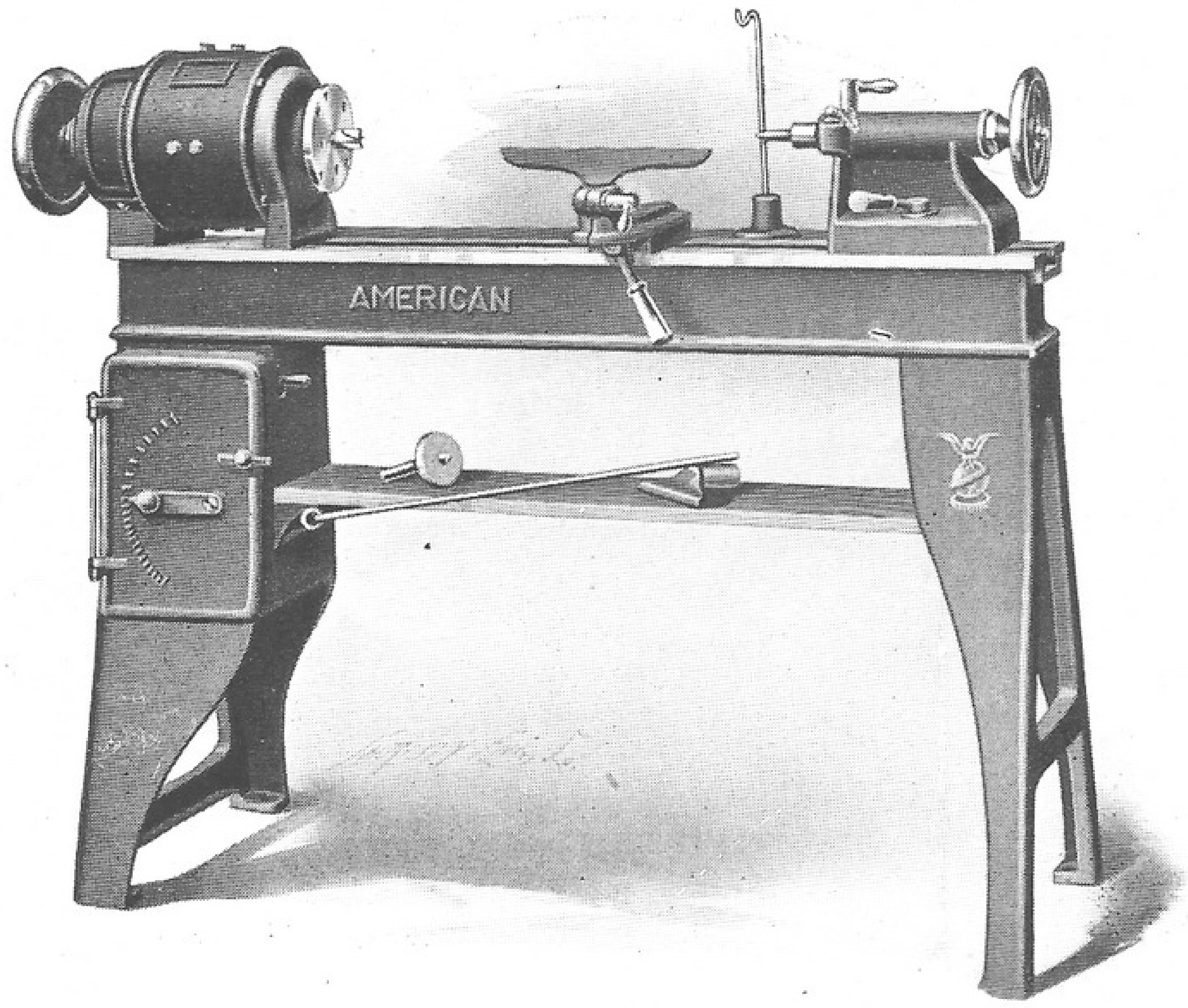
12-Inch Speed Lathe

Designed especially for Manual Training Schools. Strictly first-class throughout its makeup.

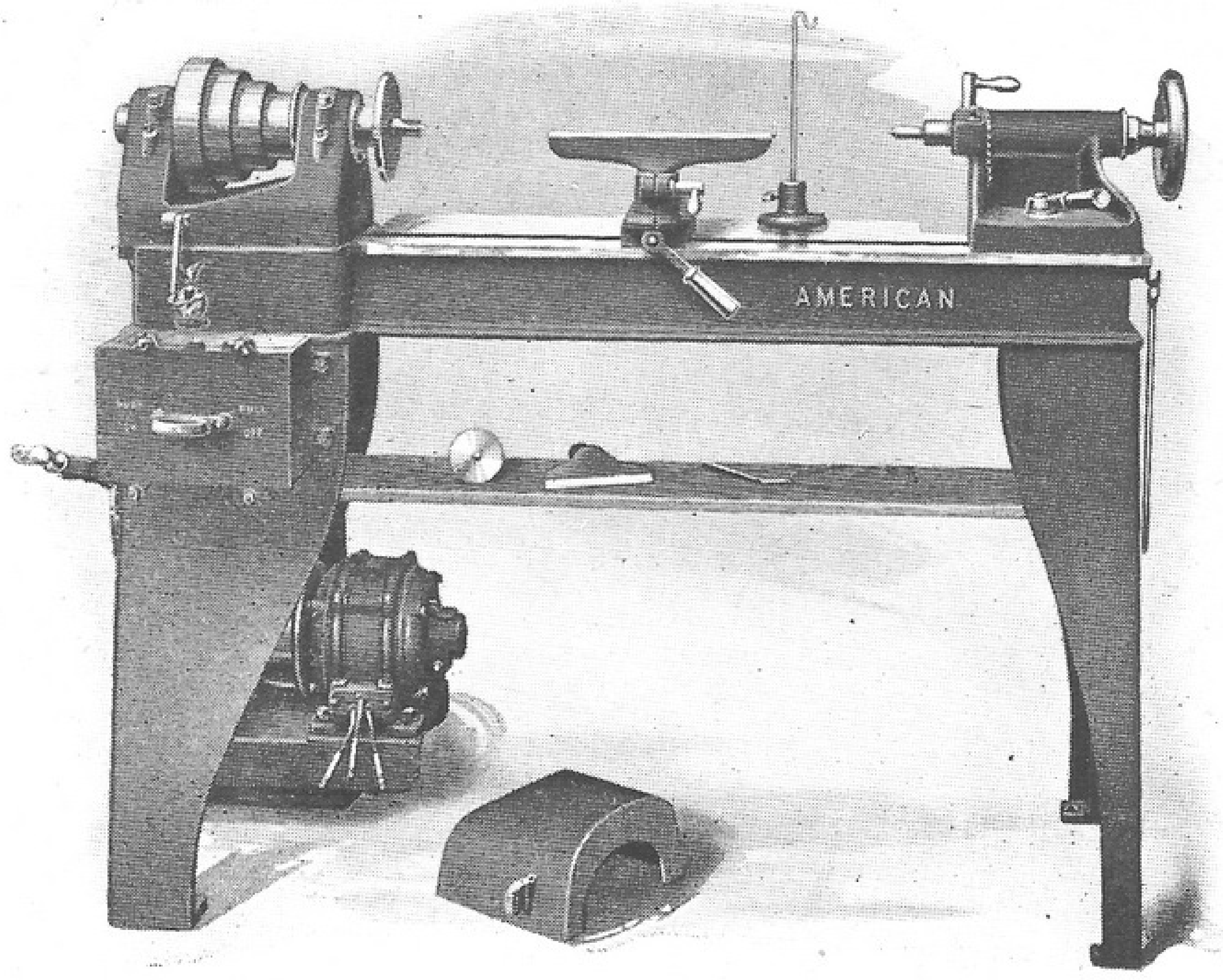
Built with or without movable carriage and set-over tail stock. Regularly made with a 55″ bed, giving a maximum distance of 26″ between centers.

Also made with 48″ and 72″ beds.

With each machine is furnished a ½″ cup centre, one 6″ face plate, one 3″ rosette chuck for interchangeable screws, one 6″ rest, one 12″ rest, one blue print holder, and one center drift for headblock.



AMERICAN 12-INCH SPEED LATHE
With Motor Headblock and A. W. C. Special Control



AMERICAN 12-INCH SPEED LATHE
With Motor mounted on Saddle underneath Headstock

SPECIFICATION

Distance from floor to center of spindle, 42″.
Distance from floor to top of bed, 36″.
Depth of bed, 5⅛″.
Width of bed, 6½″.
Width of belt on lathe, 1½″.
Width of belt on tight and loose pulleys, 2″.
Diameter of driving shaft, $1\frac{5}{16}$″.
Horse power ½.
Weight, 560 lbs.

Disc Sander

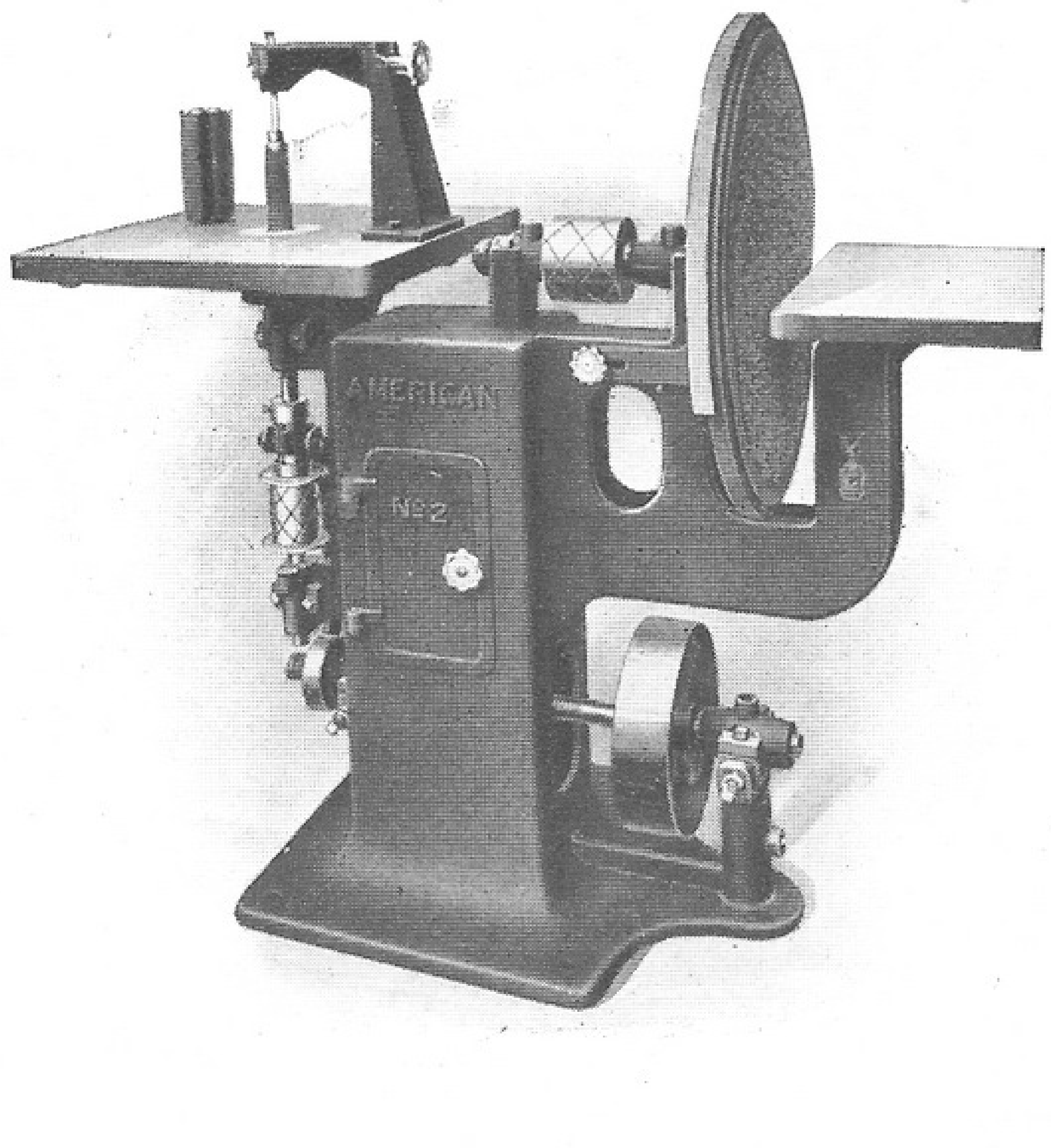
This sander will handle any work arising in the school room.

Frame cast in one piece with broad foot flanges eliminating vibration.

Each frame contains a tool chest.

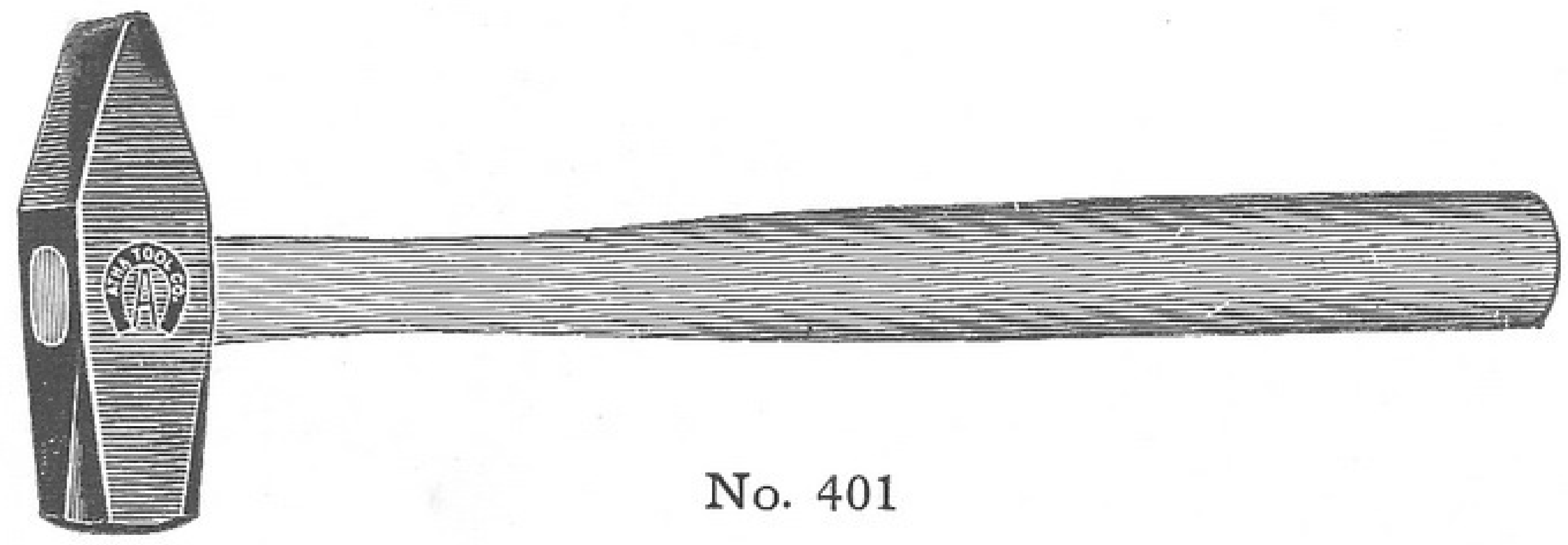
The disc is made of kiln dried wood, glued up of three thicknesses. It is usually 27″ in diameter, with working face 24″. Disc table can be tilted to an angle for bevel work.

Floor space, 5′ x 6′.
Horse power, 1 to 3.
Weight, 1000 lbs.



Blacksmiths' Anvil Tools

Hand Hammers

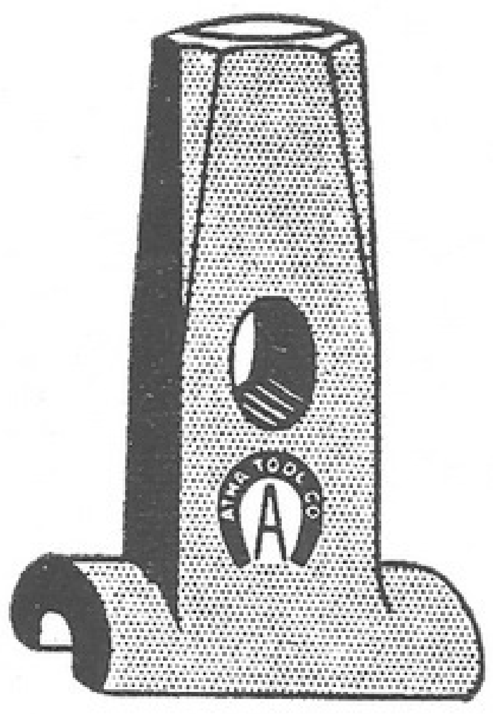


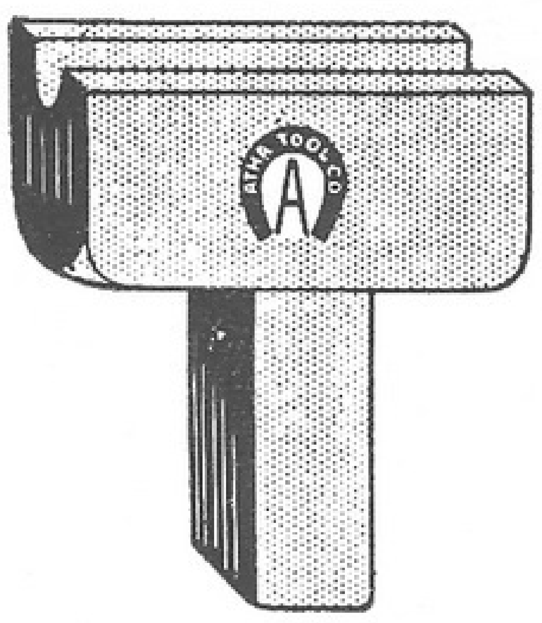
No. 401

No. 401—Size No. 1.—Plain eye, polished, hickory handle, weight 2 lbs., length 16″.

SWAGES

No. 1190

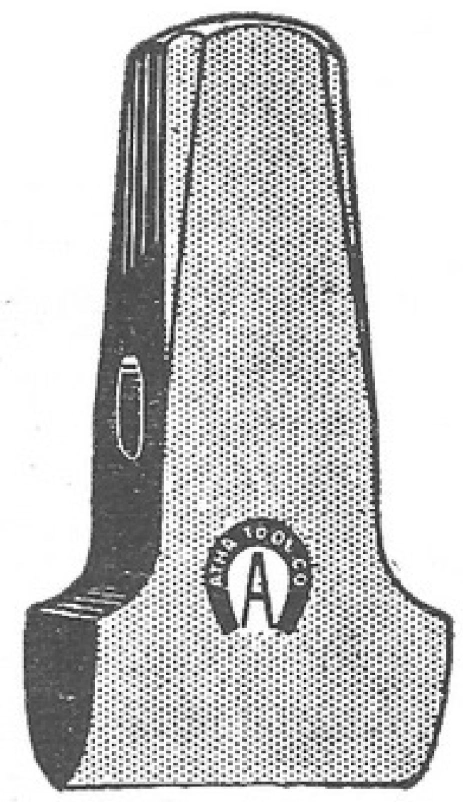


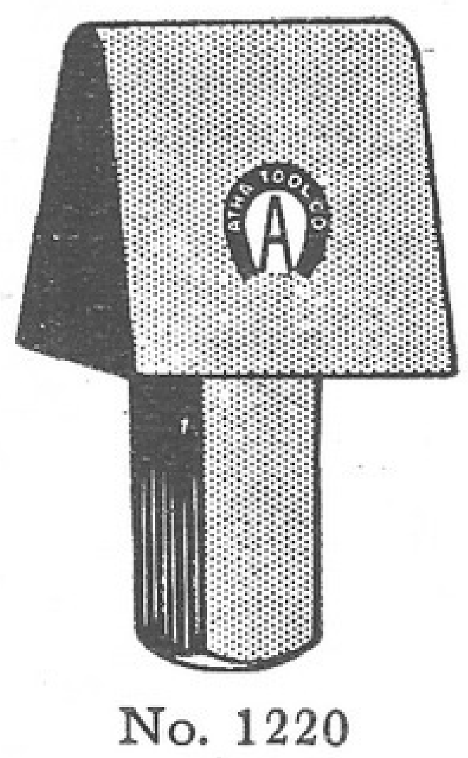


No. 1200

FULLERS

No. 1210





No. 1220

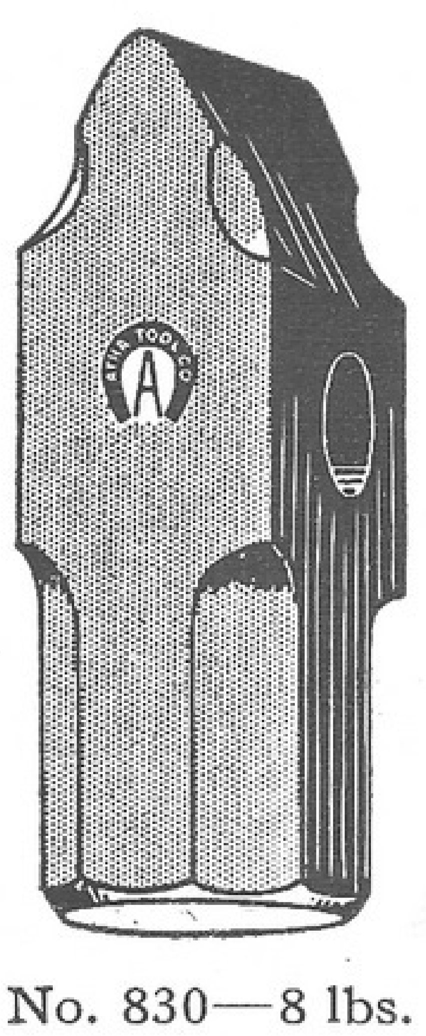
SWAGES are used for shaping, sizing and smoothing round forgings. The sizes here given are the diameters of round bar to which the swage will finish.

No. 1190—Top Swage; size ½″, weight 2½ lbs.
No. 1190—Top Swage; size ¾″, weight 3¼ lbs.
No. 1200—Bottom Swage; size ½″, weight 2½ lbs.
No. 1200—Bottom Swage; size ¾″, weight 2½ lbs.

FULLERS are used for necking and grooving forgings and also for drawing down a forging to a smaller section. The catalog size is the diameter of the working edge.

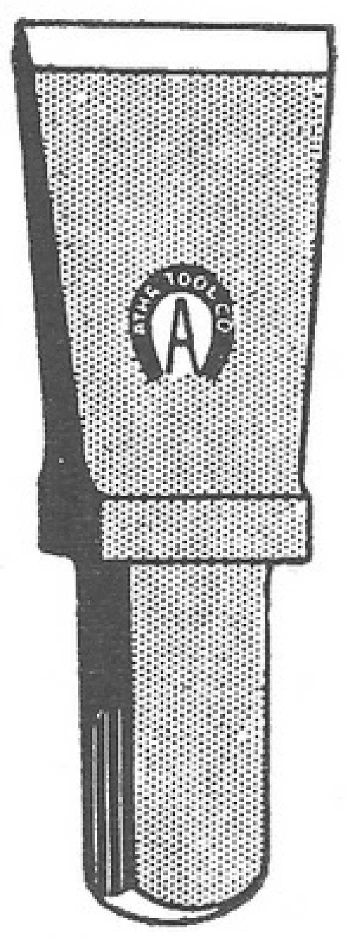
No. 1210—Top Fuller; size $\frac{5}{16}$″, weight 2½ lbs.
No. 1220—Bottom Fuller; size $\frac{5}{16}$″, weight 2¼ lbs.

SLEDGE



No. 830—8 lbs.

HARDIE



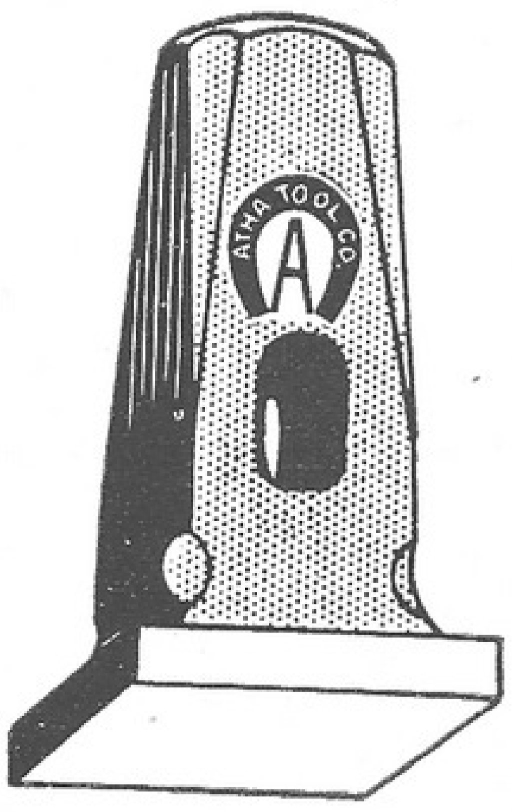
No. 1310

No. 830—Cross Pein Sledge Hammer—Black Japan finish; polished face, weight is approximate. Pein 2¼″; length 7″, diameter face 2½″, weight 8 lbs.

HARDIES are tools which set in the anvil and are used for cutting off forgings.

No. 1310—Square shank, ⅞″; width of bit 2″, weight 1¾ lbs.

Blacksmiths' Anvil Tools



No. 1230

Square Flatter

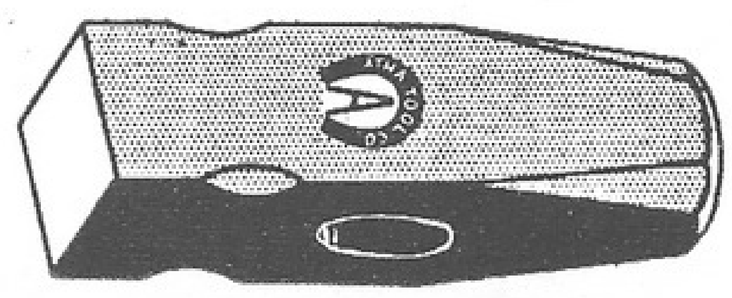
Square Flatters are used for smoothing and finishing flat forgings. No bottom tool is required, the anvil serving as such. The round flatters are available in certain places where the corner of a square flatter would be objectionable.

No. 1230—Square Flatter; size 2¼″, weight 2¼ lbs.

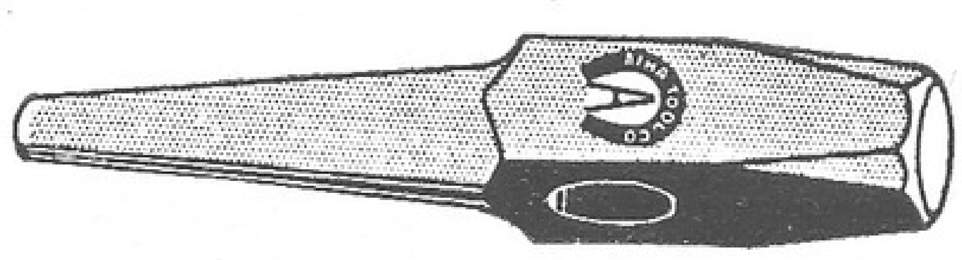
Set Hammers

Set Hammers are used for setting down the metal in a forging to form a square corner at a point where the section changes.

No. 1250—Set Hammer—Face 1⅛″, weight 1¼ lbs.



No. 1250—3 lbs.



No. 1270—1¾ lbs.

Round Punch

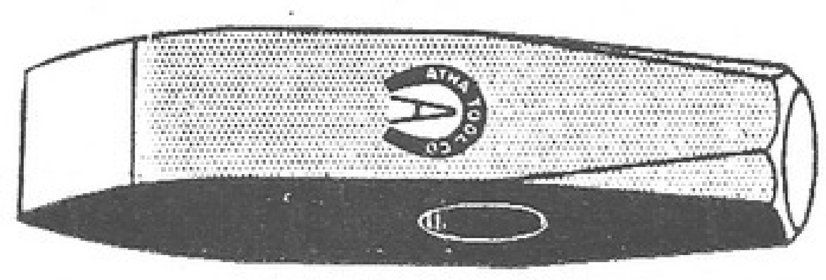
Round Punch—the size given is the size of the punch face.

No. 1270—Round Punch; size ½″, stock at edge 1¼″, length 7½″, weight 2 lbs.

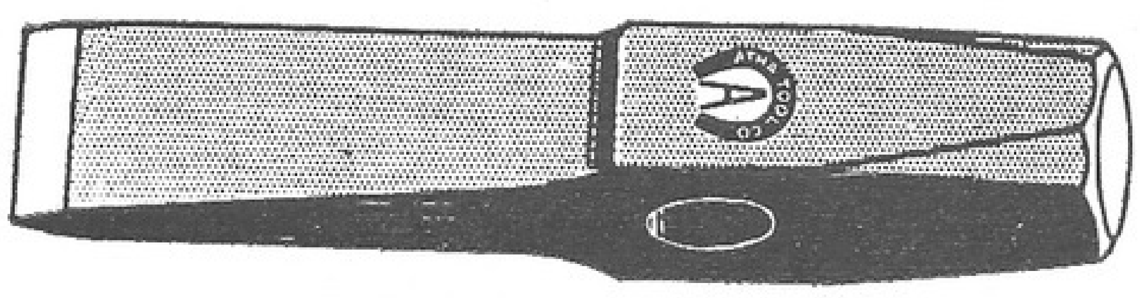
Cold Chisel

The size given is the width of the cutting edge.

No. 1290—size 1¼″; stock at eye 1¼″, length 5⅞″, weight 2 lbs.



No. 1290 — 3 lbs.



No. 1300—3 lbs.

Hot Chisel

No. 1300—size 1⅜″, stock at eye 1″, length 6″, weight 1¼ lbs.

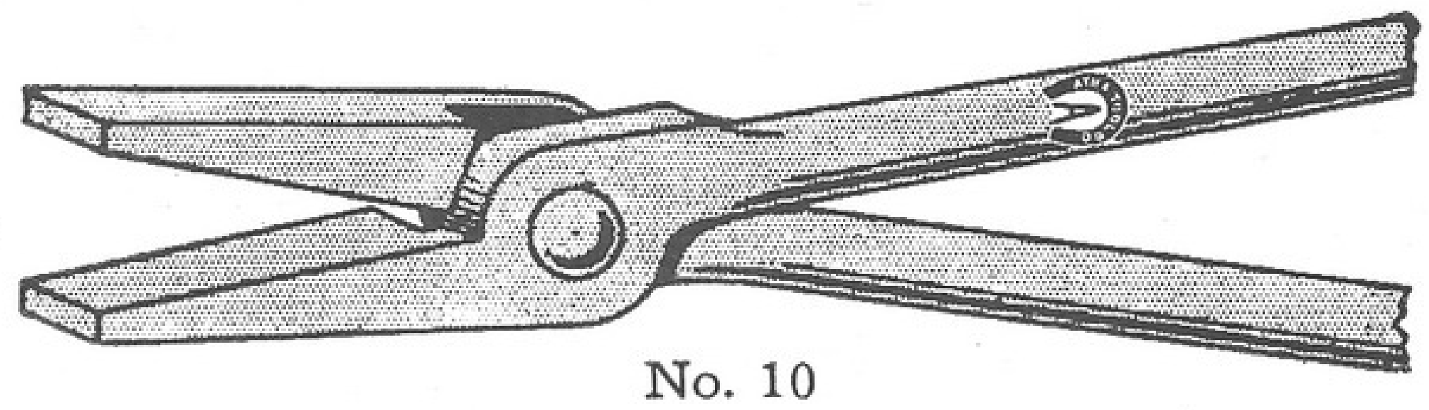
Blacksmiths' Anvil Tools

Tongs

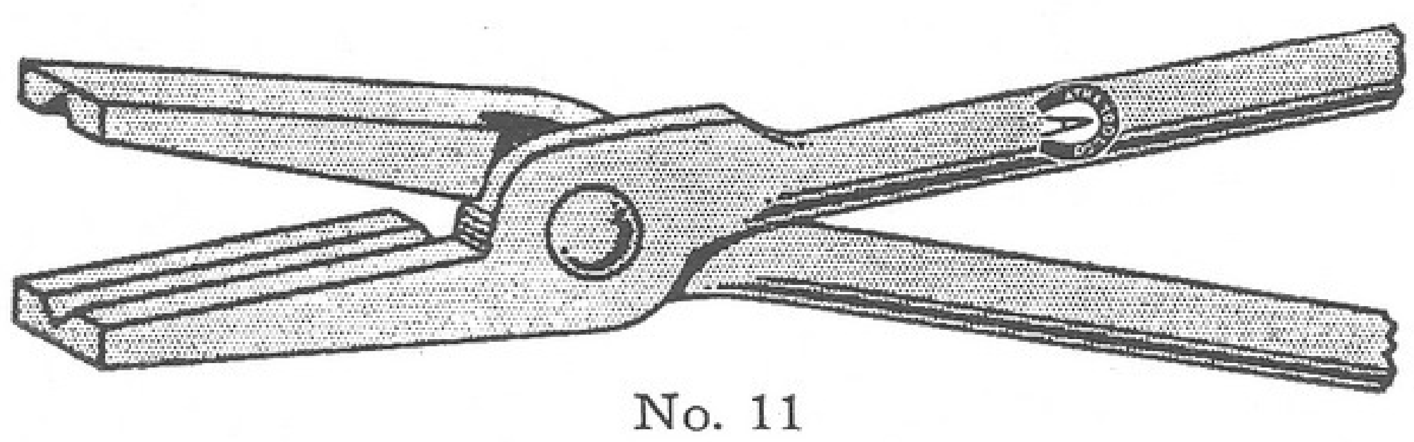
All tongs illustrated are made of solid steel. The weights are approximate. The size given is the overall length. In the illustrations the handles are broken so as to show the heads sufficiently large to clearly indicate the variations in the different numbers.

No. 10 has straight lip used for holding thin flat work. On account of the heavy stock in the jaws, they may be shaped by the blacksmith to suit his individual needs.

18″ long, weight per doz., 35 lbs.



No. 10



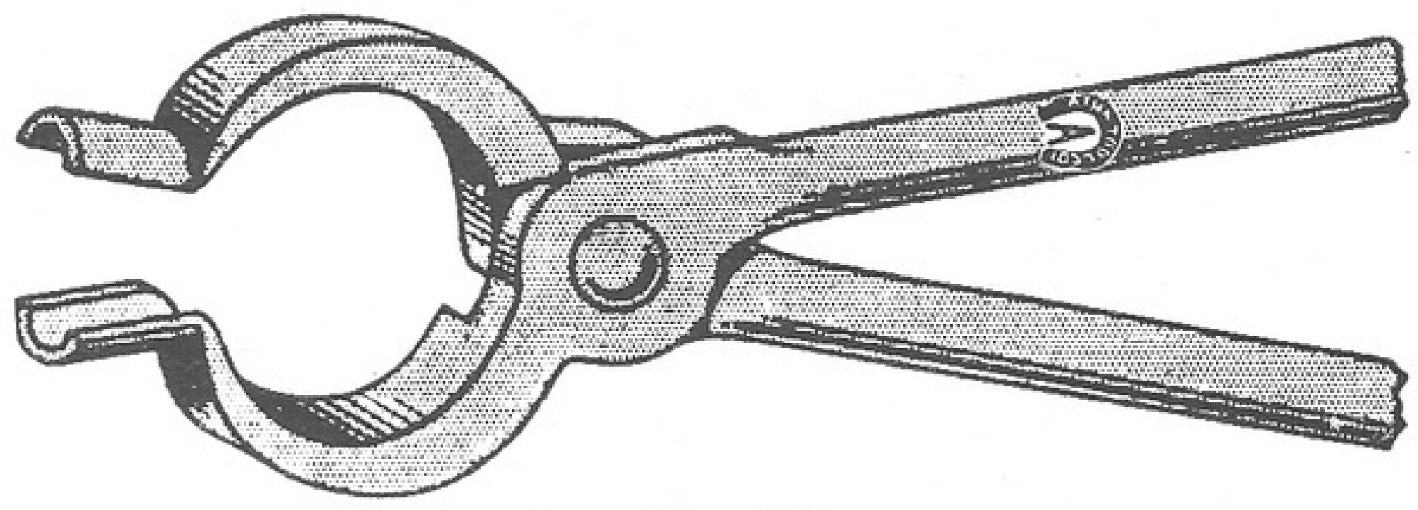
No. 11

No. 11. Straight lip to hold squares. These tongs have a "V" notch in each jaw so that they can firmly hold square or round work, though ordinarily meant for squares.

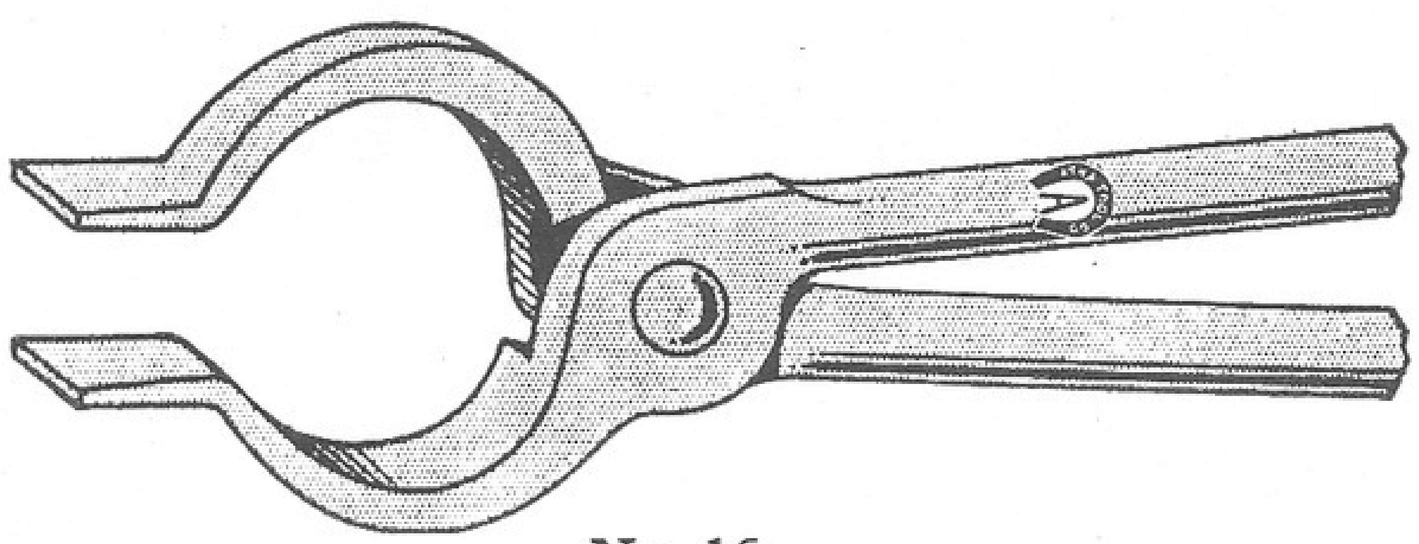
18″ long, to hold ¼″ squares, weight per doz., 32 lbs.

No. 12 has a curved lip fluted jaw; sometimes called bolt tongs. They are used for holding bolts or other round work. The opening between the jaw and the hinge allows ample space for the head of a bolt.

18″ long, to hold ¼″ rounds, weight per doz., 32 lbs.



No. 12



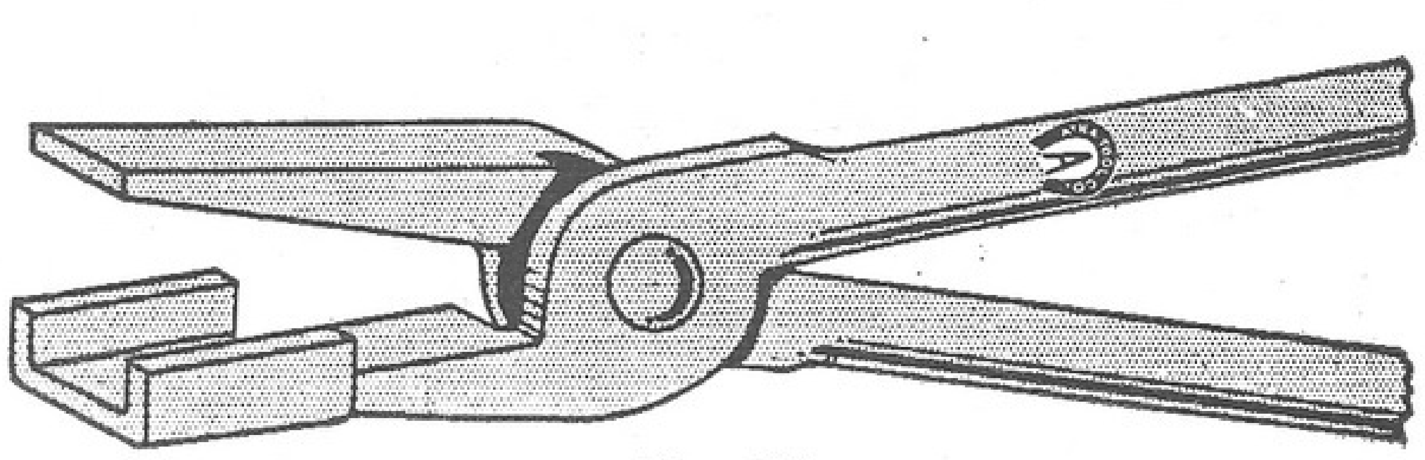
No. 16

No. 16. Tongs for general forging purposes.

18″ long, flat jaw, weight per doz., 31 lbs.

No. 18. Tongs for holding bar stock when forging lathe tools.

18″ long, holds stock ¾″ x ⅜″, weight per doz., 32 lbs.



No. 18

Notes for Forge Shop Practice

Notes on Iron

IRON. Iron is the most important of the metallic elements, silvery white in color when pure, very tenacious, malleable and ductile. Iron was first produced in America in 1622 near the James River, Virginia. It is used in the industrial arts in four forms—cast-iron, malleable iron, wrought iron and steel, each form having its own marked physical properties, fitting it for a special purpose.

CAST-IRON. Cast-iron is an alloy. It is often called pig-iron because of the fact that it is molded in little bars or pigs as it runs from the furnace. The process of making this iron is that of smelting or melting the ore in a blast furnace in connection with various fluxes, particularly limestone. These furnaces are from 50 to 60 feet high and are called "blast" furnaces because the blast is forced into them. This species of iron is extremely brittle and melts at a relatively low temperature; is crystalline in construction and can only be used for such articles as may be made or cast in molds. It contains a large percentage of carbon and usually silicon, phosphorus and sulphur. The amount of carbon varies from 1.5% to 4.5%.

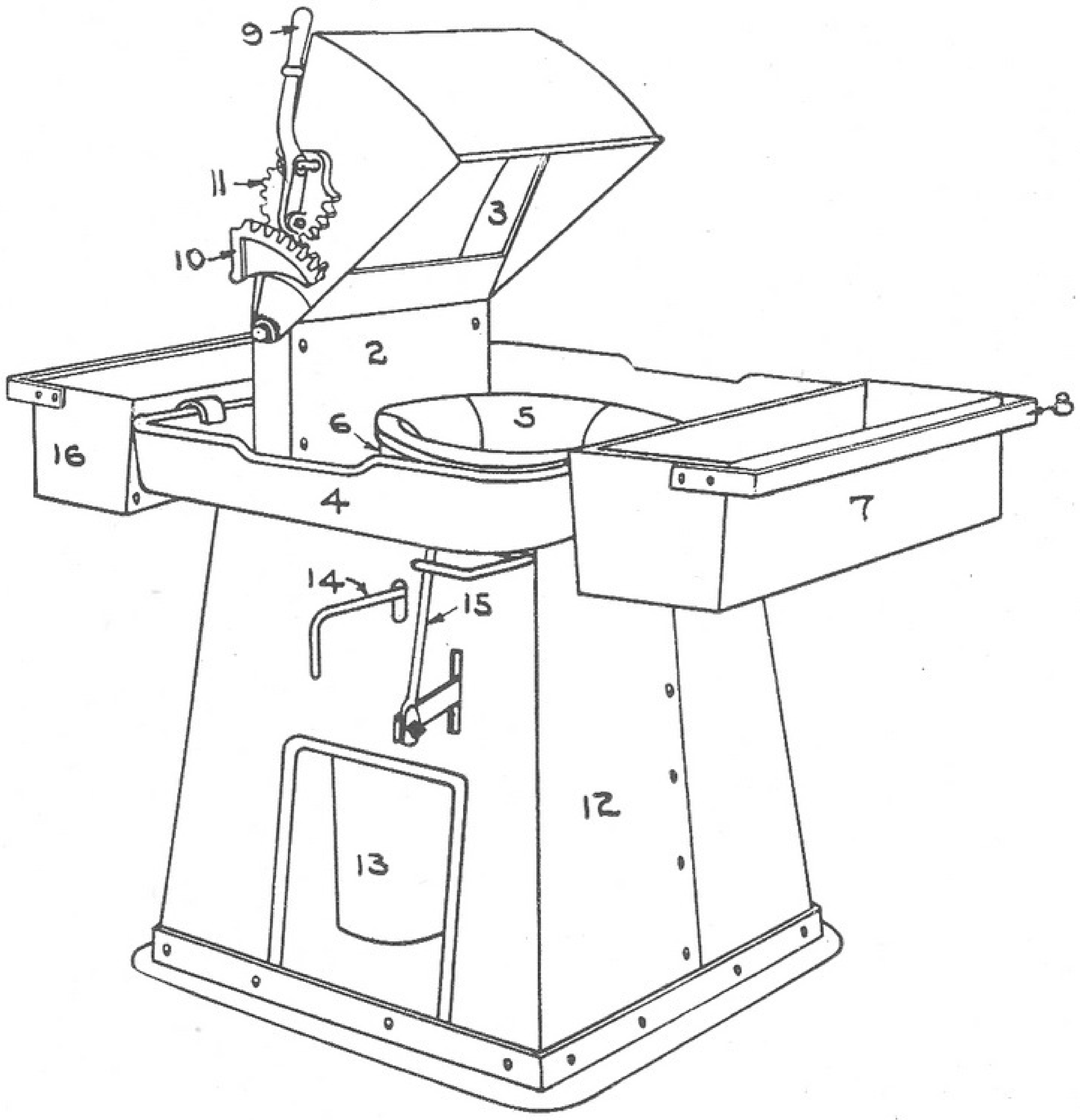
MALLEABLE IRON. Malleable iron is cast-iron which has been toughened during the process of baking in an oven for six or eight days. This decarbonizes the cast-iron.

WROUGHT IRON. Wrought iron is the extreme of the series. It is an alloy of iron and comes the nearest to being pure, having an extremely small percentage of carbon, practically none. It is very malleable, fusing at a very high temperature; becomes pasty during a considerable range of heat; will keep in a malleable condition above a red heat, which is much below the fusing point and thus can be bent and formed into different shapes with the hammer. Iron work produced in this way is called Wrought Iron. Wrought iron manipulated when hot is said to be forged. Two pieces brought to a fusing point may be united into one piece by hammering. Pieces so united are said to be welded. It will not become hard and brittle like cast-iron as it is of a fibrous construction; it shows a high tensile strength at a fracture. This iron is divided into two classes—common or refined iron and Norway iron. Wrought iron has been largely displaced for most purposes by the increased production of steel. The iron used in making the exercises in this course should be Norway iron as better results are attained than by using common iron.

PUDDLING. The general process of making wrought iron at the present day is known as "puddling." This process was invented about the year 1780 by Henry Cort

Notes for Forge Shop Practice—Continued

and improved about fifty years later by Joseph Hall. The method employed is one of melting cast-iron in a chamber or on the hearth of a reverbatory furnace, the flame passing over the molten metal. The requisite time for this operation is about thirty minutes. When the metal becomes melted, an oxidizing metal is added. All phosphorus, sulphur, carbon and other impurities may be eliminated by stirring. During the melting a slag forms and adjusts itself to the iron around each fibre, showing a fibrous rather than a crystalline structure.. There are many varieties of furnaces of various capacities; the capacity of the most common size ordinarily being from 500 lbs. to 1500 lbs.



THE FORGE AND ITS PARTS

1. Adjustable Hood
2. Stationary Hood
3. Front Plate
4. Hearth
5. Fire Brick
6. Fire Pot
7. Water Tank
8. Tool Rack
9. Adjusting Lever
10. Segment
11. Pinion
12. Base
13. Exhaust Pipe
14. Tuyere Lever
15. Blast Gate Lever
16. Coal Box

The Art of Welding

SOME metals, when heated, become gradually softer as the temperature increases, until a heat is attained at which the metal is in such a condition that if two separate pieces are brought into contact by slight pressure, they will adhere and form a single piece. Every metal is not affected in this manner. Cast-iron, for instance, does not become gradually softer as the heat is increased, but remains firm until a certain temperature is reached and then softens suddenly and goes to pieces. Any metal which softens gradually when heated, may be welded, while metals which act as cast-iron, cannot be welded. The condition at which pieces of metal are ready to adhere, is known as the welding heat. The two pieces of metal properly shaped are brought to this welding heat, placed together and thoroughly hammered, or forced together by pressure in such a way as to bring the two pieces into contact at all parts of the weld. The weight of the blow must be governed by the size of the bar, as the blow must be sufficient to affect the metal from the surface to the center. With this precaution a good weld may be produced. It is necessary to make some of the most difficult welds at one heat, as it is often impossible to re-heat. In all welding, the greatest care must be observed to heat the piece properly. A piece of wrought iron, when brought to a welding heat, is almost white, and little explosive sparks appear upon the surface. These little sparks are small particles of iron which become separated from the bar and burn.

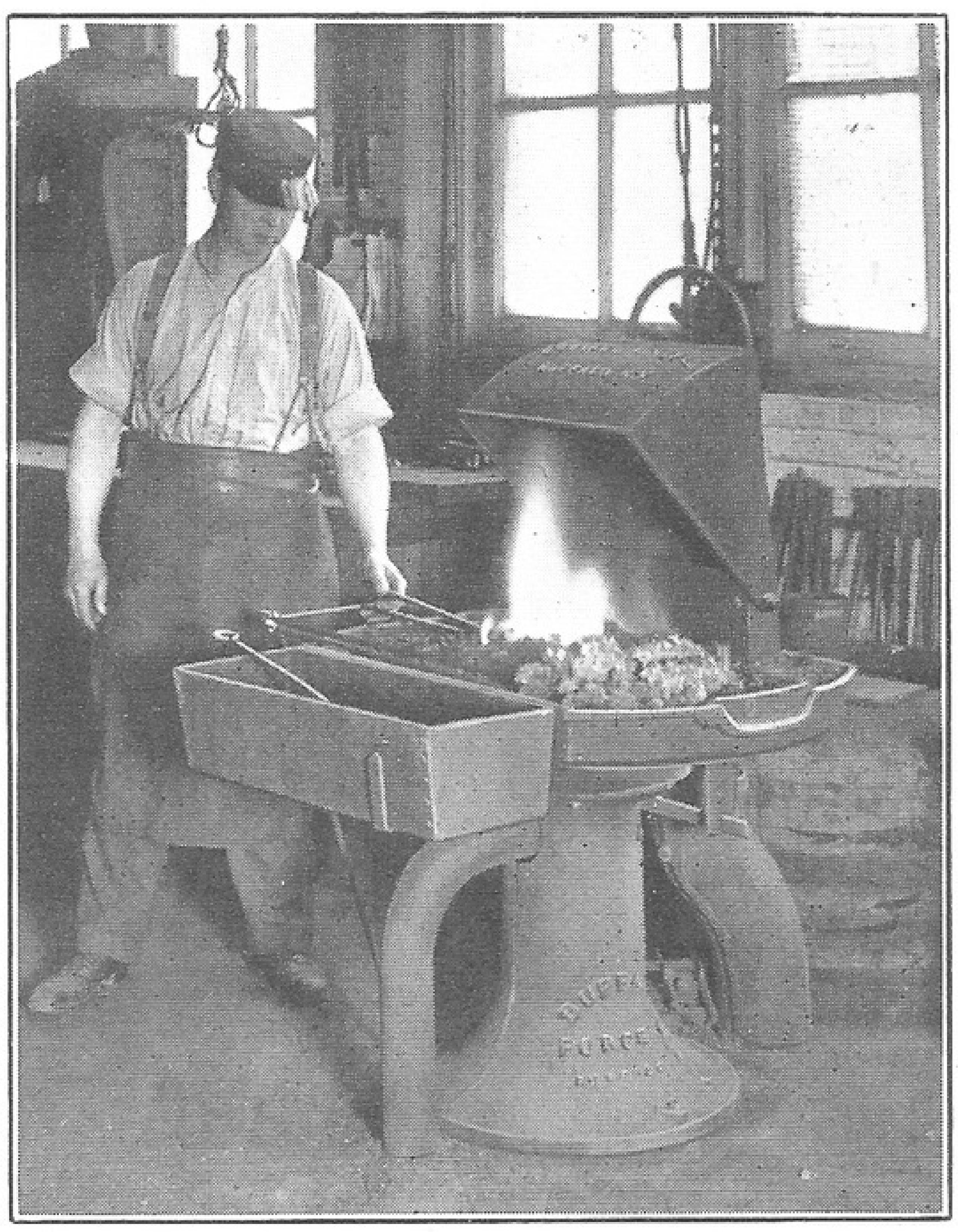
FIRE FOR WELDING. It is very essential to have and maintain a good fire during the process of welding. Good coal and material are among the essentials. The good fire is indispensable in order to attain the best results in welding. Tuyere iron must be well covered with coke and the fire must be absolutely free from all clinkers and well banked with green coal, burning up quickly to allow all gas to escape. Keep plenty of coke on top of the iron. Do not continually poke the fire.

OXIDATION OF IRON. If a piece of iron is heated in contact with air, it will absorb oxygen from the air and form a scale, upon the surface which is known as oxide of iron. The hotter the iron, the more rapidly this scale will form. The scale does not adhere firmly to the iron and cannot be welded. Two methods are used to guard against oxidation. In the first it is accomplished by having a thick bed of fire for the air to pass through before coming in contact with the iron and by maintaining a moderate blast. The second method is by coating the surface of the iron with a substance called flux, which lowers the melting point of the scale and makes welding easier. This flux is formed by a fusible mixture which offers protection to the iron. The most common flux for iron is clean, sharp sand and borax; the latter is used for fine work and steel. To weld steel is quite a different proposition, for the welding temperature of steel is, on account of its greater fusibility, considerably less than that of iron. There are so many different kinds of steel that the same rule will not apply to all of them. Cast tool steel is the most difficult to weld.

THE SCARF OR LAP WELD. This weld is the one usually adopted by smiths and is the best when it is practicable. For most welding, the ends of the pieces must

The Art of Welding—Continued

be so shaped that when welded together, they will form a smooth joint. This shaping of the ends is called "scarfing" and the shaped end is called a "scarf." The scarfs should be so shaped that when placed together they will touch in the center leaving the sides open. In this way the scale is forced out between the pieces. If the pieces should join on the sides and leave the center hollow the scale would be imprisoned, making a bad weld. Prior to making a scarf weld, the metal should be reinforced or upset, as far back as it is to be exposed to the intense heat. This upset allows for wasting away. In case of failure to make a perfect weld at the first heat, then a second heat should be taken. No sign of the scarf should be seen on a perfect weld. For ordinary lap weld the length of the scarf may be made one and one-half times the thickness of the bar. If the scarfs are long, the laps must be long. In welding a round bar, the scarf is made the same as the lap weld except that the scarf should be drawn to a sharp point instead of to a chisel edge. This is done in order that the corners may not project beyond the edge of the bar when welding, thus causing considerable trouble. Place the pieces in the fire with the scarf down, as the under side of the iron is always the hottest. Do not heat the iron too quickly as it will come to a welding heat on the outside and yet not be thoroughly heated, so that when exposed to the air, it will cool too rapidly. When each piece has attained a clean, white heat, remove them, giving each a jar upon the anvil while the scarf is down thus dislodging any dirt which may have adhered. Turn the one in the right hand over and place the other on top of it, bringing them together as quickly as possible. In putting the two pieces together, the point of one scarf should just meet the heel of the other. Hammer rapidly, in order that they may become united before the heat gets below the welding point. The cold anvil very quickly reduces the heat.



Steel and Its Manufacture

STEEL is the name applied to carbonized iron, having a high tensile strength combined with elasticity. It was first made by the ancient Egyptians and other early races, by reducing very pure iron ore mixed with chopped wood, in clay crucibles, which were heated in charcoal fires blown by goat skin bellows. From this steel, the celebrated Indian sword blades were fashioned. No finer tool steel has ever been made. The term "steel" as used in early times, designated a form of carbonized iron which would harden or "temper" when dipped in cold water, after having been heated to a red heat. This definition no longer holds good, as the carbonized iron produced by modern methods and used extensively in structural work, goes by the name of steel. Up to the time of the invention of the open hearth process, the only commercial process of making steel was by decarbonizing cast-iron, and then recarbonizing the resulting wrought iron in the cementation furnace. Steel may now be defined as a metal produced by a complete fusion of iron or iron alloys, in a bath, the necessary properties being given after conversion by the addition of carbon or carbon alloys. Many theories have been advanced as to what steel really is. One held by many metallurgists is that "steel is an alloy of pure iron and carbon only," all other elements being regarded as impurities. Good steel is of a bluish, gray color, uniform in grain and having little lustre.

There are three distinct methods used in making steel, the Open Hearth, the Bessemer and the Crucible. The latter is the oldest of the present methods of manufacture, having been in use for centuries. The first two methods are probably the ones most commonly used at the present time. In these, the carbon in the cast-iron is burned out, while in the last method, the carbon is burned into the wrought iron. Other methods formerly used, were Cement or Blister steel and Shear steel. In commercial importance, the processes rank, Open Hearth, Bessemer and Crucible. It was not until the Open Hearth and Bessemer processes came into use that steel began to supplant wrought iron to any extent.

OPEN HEARTH STEEL. This method of making steel was discovered about the year 1845. It is under better control than the Bessemer process, since at any time it affords opportunity for testing and for making such additions as may be necessary to yield the desired product. The open hearth furnace also permits of the highest temperature without requiring a strong draft. These furnaces are built to hold from ten to fifty tons of metal. The time for an operation or "heat" is from eight to eleven hours. Steel rails, structural materials, plates, etc., are produced by this process.

BESSEMER STEEL. The Bessemer process is named after its inventor, Sir Henry Bessemer, an Englishman, and was introduced in 1856. For many years after its introduction it ranked first among all the processes. Bessemer steel is made by decarbonizing cast-iron by forcing a current of air through the molten metal in a pear-shaped crucible or vessel called a "converter." There has been little change in the design of the converter from that originally used. A common size of this converter has the following dimensions: Diameter 8 ft., height 15 ft. It is made of boiler plate, lined with refractory material. It is suspended upon an axis to admit of its being turned from an upright to a horizontal position. In the bottom there are twelve tuyeres, which have to be replaced after about twelve to fifteen blows or heats. The usual capacity of the converter is from six to fifteen tons of cast-iron. The blast of air forced through the molten cast-iron, produces great heat. The resulting gas and flame escapes from the mouth of the converter, the combustion of carbon and silicon producing a temperature sufficient to keep the mass thoroughly melted, thus quickly burning out the carbon and silicon, this last result being indicated by the color of the flame. The molten metal is poured into a ladle and then there is added to it, manganiferous pig-iron, which reintroduces the necessary amount of carbon and manganese. This entire process takes about twenty minutes. It is then cast into ingots, and, after being treated in the reheating furnace or "soaking-pit" is rolled to the required thickness. Bessemer steel is used for nails, screws, wire, and in fact, for all products where cheapness rather than quality is the requirement.

Steel and Its Manufacture—Continued

CRUCIBLE STEEL. Crucible or tool steel, the oldest and simplest process, takes its name from the methods employed in its manufacture. In this process, carbon is added to a low phosphorus and sulphur wrought iron. Swedish or Norway iron is used in preference to other kinds, as it has proved superior in making high grade tool steel. This iron is cut into small pieces one inch long from flat iron bars, 2″ x ½″. These pieces are then placed in a clay crucible (sometimes a graphite crucible is used, although it is not as good) which is about 20″ high and 1 foot in diameter. A certain amount of powdered charcoal is mixed with these pieces and the crucible is then tightly sealed, and subjected to great heat which melts the iron. After having remained in a molten state for some time, it is poured into molds and form-ingots which are afterward rolled or hammered under a steam hammer into bars. This process has undergone but little change in all the years it has been employed, the only important change being a more direct method for introducing the carbon into the steel. In the main, however, the method now used is the same as that used centuries ago. Owing to the high cost of production this method is now used principally for making high grade tool steel. The elasticity of this steel, makes it of use in many places where no other steel could be safely used.

TEMPERING. The term "temper" as used by steel makers, refers to the percentage of carbon in the steel. It has a different meaning when used by the steel maker than when used by the hardener. In the steel mill, it means the amount of carbon the steel contains. According to "Metcalf" the meanings may be tabulated as follows:

Very high temper	150 carbon
High temper	100 to 120 carbon
Medium temper	70 to 80 carbon
Mild temper	40 to 60 carbon
Low temper	20 to 30 carbon
Soft or dead soft temper	20 carbon

A point is 1⁄100 of 1% of any element that enters into the composition of steel, so: a 150 point carbon steel, contains 1½% carbon. In the steel mill such a steel is spoken of as 150 steel. "Tempering" on the other hand, denotes the process by which steel is brought to a previously determined degree of hardness. A steel chisel can be made so hard that it will cut another piece of steel; or so soft that driving it into a piece of hard wood will dull its point. This property of steel enables the mechanic to make it into tools suitable for any kind of work. Steel is tempered by various means, all of which depend upon a heating and subsequent cooling of the metal. For instance, a piece of tool steel which is heated to a cherry red heat and then plunged into cold water, becomes very hard. If allowed to cool slowly, it becomes soft. Between these extremes all degrees of hardness can be obtained. Every tool is tempered to the hardness that makes it most useful. When a polished piece of steel, hardened or unhardened, is exposed to heat in the presence of air, it assumes different colors as the heat increases. First will be noted a faint straw color, which changes to a deeper straw, then to a dark brown with purple spots, then to a dark blue, and finally to a light blue. These colors are due to a thin film of oxide that forms as the heat progresses. These colors are valueless, however, to the tool maker unless the metal has first been cooled in a bath of water, oil, or some other liquid, when at a red heat. Drawing hardened steel to any of these colors is called "tempering." The following list of colors applies to all of the tools we are likely to make:

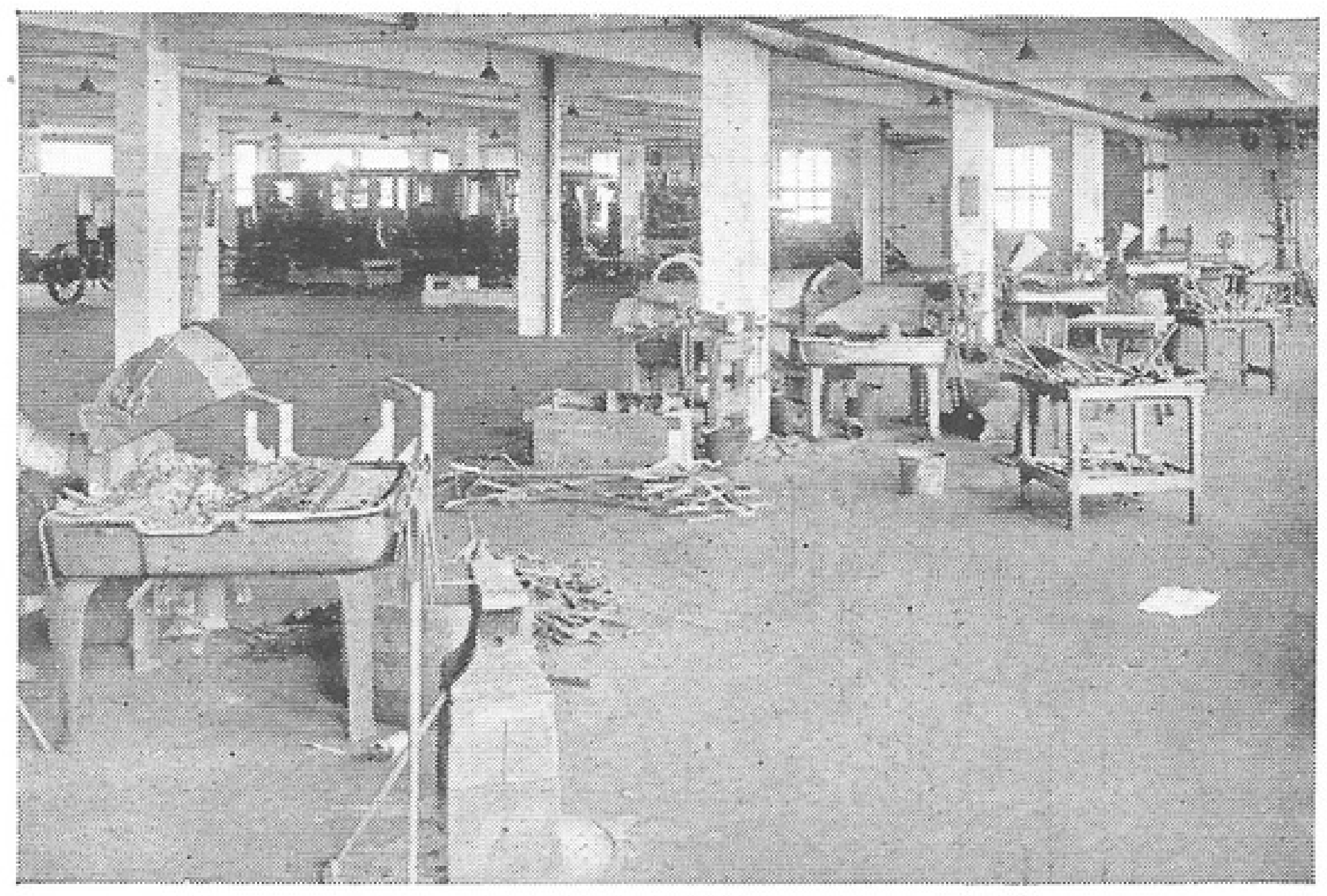
COLOR	TOOL
Pale or light straw	Lathe tools
Dark straw	Taps, dies, milling cutters, etc.
	Woodworking tools (cooled in oil)
Purple	Center punch, stone drills
Dark blue	Cold or cape chisels
Light blue	Screw drivers

Steel and Its Manufacture—Continued

TOOL TEMPERING. Let us consider the tempering of a tool, taking, for example, the cold chisel, a tool widely known and generally abused. To obtain a good chisel, it must be properly forged at a comparatively low heat, and then hammered with light blows at the last until it has cooled considerably below the heat ordinarily used when metal is displaced. The object of the light blow on the cooling metal, is to close the grain or refine the steel, making it tough. Tools of this character stand up better if they are heated to a cherry red heat and allowed to cool before hardening. This is not always possible, but when it is, make the hardening heat a separate operation. To harden, heat two-thirds of the part forged to a cherry red heat, using great care not to overheat the point, and then cool one-half of the blade in cold water; always move the tool about or set the water in motion, avoiding any danger of making a water crack at the water edge. The next operation is to brighten one broad surface with an emery stick. A piece of emery cloth tacked over a stick of wood makes a very good polisher. The heat remaining in the body of the chisel will reheat the end already cooled, and the various colors will appear in order on the polished surface. The proper color for a cold chisel when correctly tempered, is dark blue. When this color is attained at the point the entire tool is then immersed in water and is not removed until cold. If the tool is not cooled off enough in the first operation, the colors will run down very rapidly and become compact, and if not watched closely, they will be gone before the tool can be cooled. When a tool is to be hardened all over, it is first heated to a cherry red heat and then cooled. After brightening with the emery stick, place on a square or flat piece of hot iron. The tool will absorb the heat and the colors will soon commence to run. When the desired color is attained cool again in water or oil. In a commercial plant where a great many tools of the same kind are made, and where the composition of the steel is known, a hardening bath is used.

SPRING TEMPERING. The method employed in hardening a spring in oil is as follows: First, heat to a cherry red heat, as in hardening in water; cool all over in oil; hold over the fire until the oil upon the surface blazes. This is called "flashing." Cool again in oil. This "flashing" is done three times before the process is complete. Another method of hardening a spring employs a water bath instead of the oil. Pass the spring over the fire or through a flame until it is hot enough to make a pine stick show sparks; then cool in water and a spring "temper" results.

ANNEALING. The process of softening a piece of steel is called "annealing." A piece of steel is softened or "annealed" prior to being worked upon in the lathe or otherwise machined, as this process brings about a uniform softening, relieving any strain that might have occurred in forging. To anneal a piece of steel it should first be heated to a cherry red heat, and then allowed to cool slowly. When long pieces of steel, or a number of pieces, are to be annealed, and a furnace is employed, the pieces are placed in a long tube or pipe, and both ends sealed. They are then brought to a cherry red heat and allowed to cool. When a piece is heated in the forge, it is covered over in the annealing box. Dry slack lime or ashes can be used for this purpose, the object being to keep the steel away from the air.



Course in Forge Practice

Elements — Suggested Problems

CARE OF FORGE

Elements

Operation of forge as to use of firepot, tuyeres, draft and blast.

Building and maintaining fires for different classes of work. Production of coke for the fire. Removal of ashes and clinkers.

FORGE AND ANVIL

Elements

Drawing.

Bending.

Shouldering.

Twisting.

Upsetting.

Forming.

Punching.

Chamfering.

Use of Finishing tools such as swages, fullers, hardies.

Suggested Problems

Gaggers, Staples, S Hook, Square Angle Irons.

Form ring for subsequent welding. Tapering round irons for drafting holes in patterns.

Burning irons for fitting chisel handles. Pointing pokers, tapping irons. Eyelet drawing pins for lifting patterns.

Pipe Hooks, Bolts of stock sizes.

Hook for whipple tree.

Upsetting stock for subsequent tool holder.

Open square jawed wrench.

Draw plates for bolts.

Brackets for tool racks.

Flat alligator wrench.

WELDING

Elements

Scarfing.
Proper heat.
Fluxes.
Lap Weld.
Faggot Weld.
Tee Weld.
Angle Weld.

Suggested Problems

Rings and Links for whipple tree.

Stock scrap used to form bar iron.

Flat angle irons, gaggers.

TOOL STEEL

Elements

Annealing heat.
Forging heat.
Hardening heat.
Case hardening.
Temper for cutting wood.
Temper for cutting iron.
High speed steel work.

Suggested Problems

Flat Cold Chisel.
Cape Chisel.
Center Punches.
Diamond Point Chisel.
Wood Turning Chisel.
Side Cutting Chisel.
Round Nose Chisel.

Course in Forge Practice—Continued

Elements	Suggested Problems

VISE WORK

Elements	Suggested Problems
Numbering and lettering work with steel stamps.	Angle Irons.
Laying out and center punching for drilling on press.	Bolts.
Reaming.	Draw Pins.
Cutting threads on bolts and draw-pins with die.	Draw Plates.
Tapping draw plate.	Anchor Plates.
Riveting.	Tool Holder.

DRILL, PRESS, SHEAR AND GRINDER

Elements	Suggested Problems
Getting out stock for standard jobs.	Iron plates of various kinds.
Drilling and Countersinking.	Machine Tool Holder.
Grinding and Finishing.	Lathe Tools.

STEAM HAMMER

Elements	Suggested Problems
Drawing.	C-clamp.
	Crucible handles.
Upsetting.	Tongs, Lever Arm.
	Mast Ring.
Forming.	Large open Wrenches.
	Connecting Rod.
Welding.	Single throw Crankshaft.
	Hammer Heads for machine shop stock.

LECTURES AND RECITATIONS

History of Blacksmithing.
Sources of Supply.
Machine Forging.
Bessemer Processes.
Open Hearth Processes.
High Speed Steel.

VISITS OF INSPECTION

General Jobbing Shop.
Steam Forge Shop.
Drop Forge Shop.
Rolling Mill.

Exercise No. 1

Stock—Norway Iron—½″ x ½″—Convenient length.

EXPLANATION—One end of the stock is to be drawn until a length of 5″ or more is ⅜″ x ⅜″. 5″ of the drawn portion is then to be cut off on the hardy end, the cut end squared.

The finished piece, Fig. 1 A, must be smooth, true to size, square in section and straight.

OPERATION—Beginning near the end of the stock, strike every other blow on a given face, and the alternate blows on one of the adjoining faces. Occasionally turn the work so that the two faces previously on the anvil may be brought under the hammer.

To mark the work where it is to be cut hold the square to the edge of the hardy across which slide the stock as indicated by the arrow, Fig. 1 B, until its end is opposite the 5″ mark on the square. Put down square, take up hammer, and strike a light blow. After this cut on all four sides, Fig. 1 C. Break the piece off by bringing the cut over the edge of the anvil, Fig. 1 D, and deliver a blow on the end of the piece.

To square the cut end, first upset, Fig. 1 E, and then draw down to size.

CAUTION—If it is discovered that the stock is becoming diamond shaped, Fig. 1 F, instead of square in section, hammer on the high sides, Fig. 1 G.

FIG.-1-A.

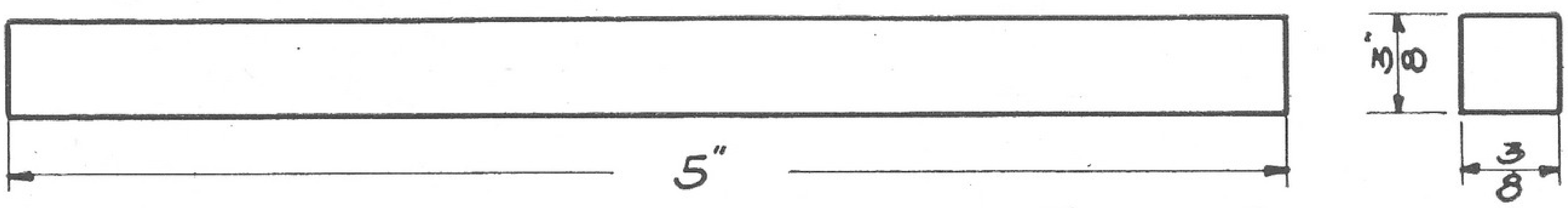


FIG-1-B

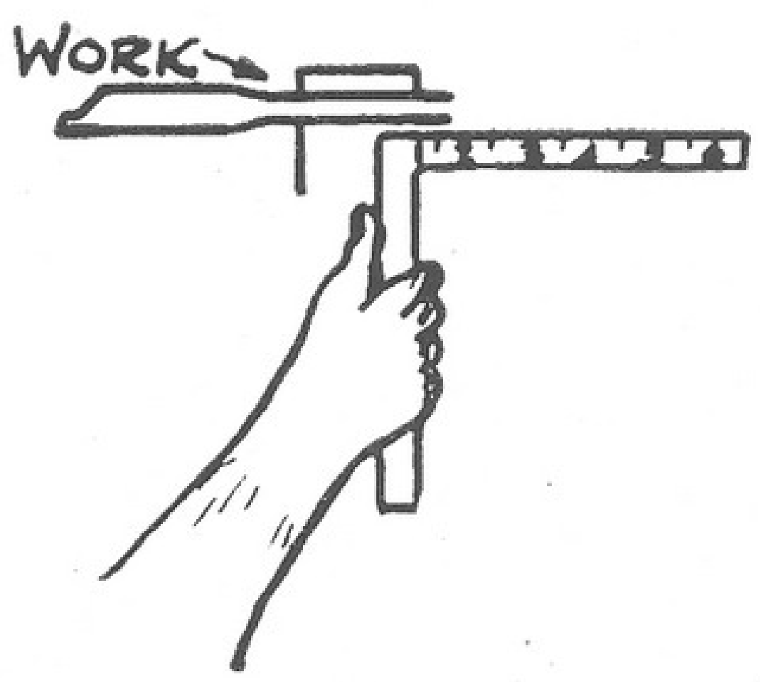


FIG.-1-C

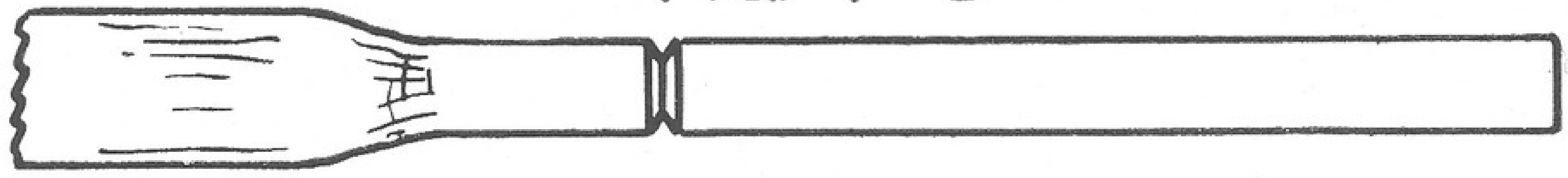


FIG-1-E

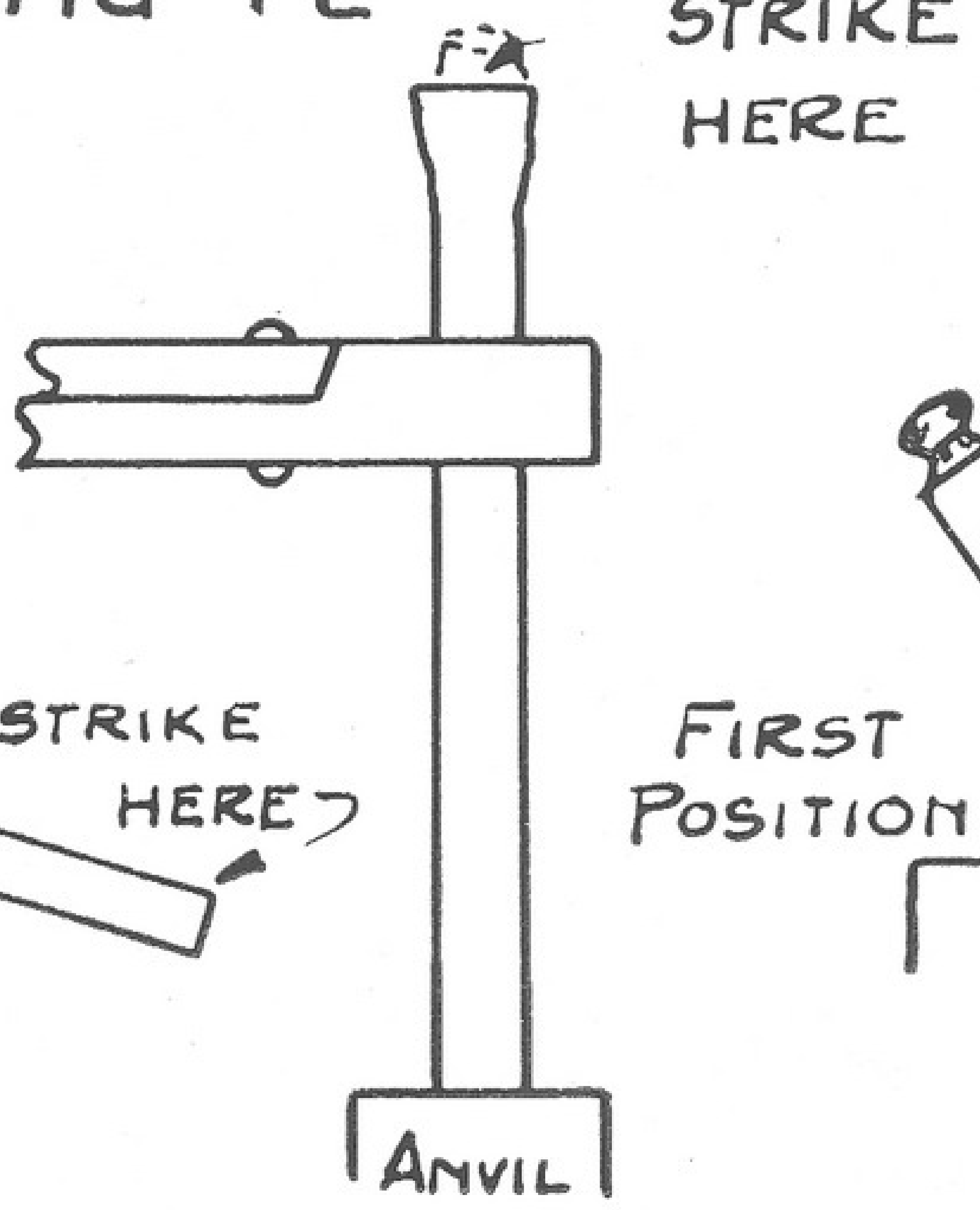


FIG-1-F

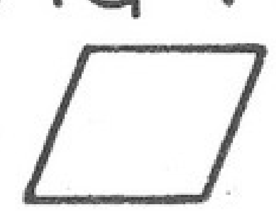


FIG-1-D

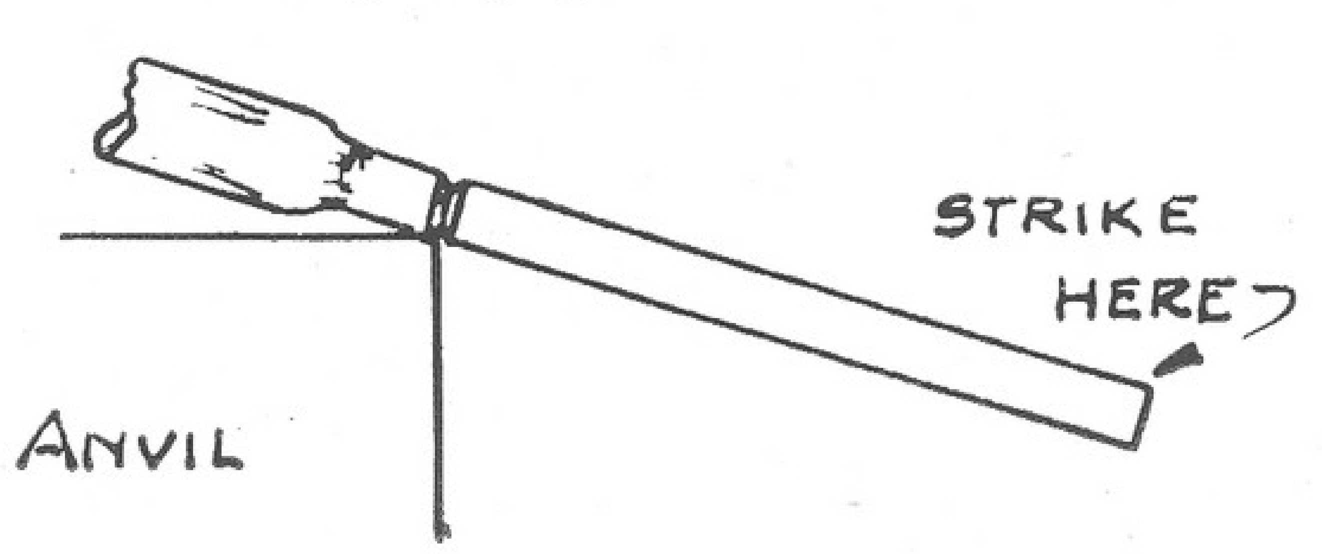
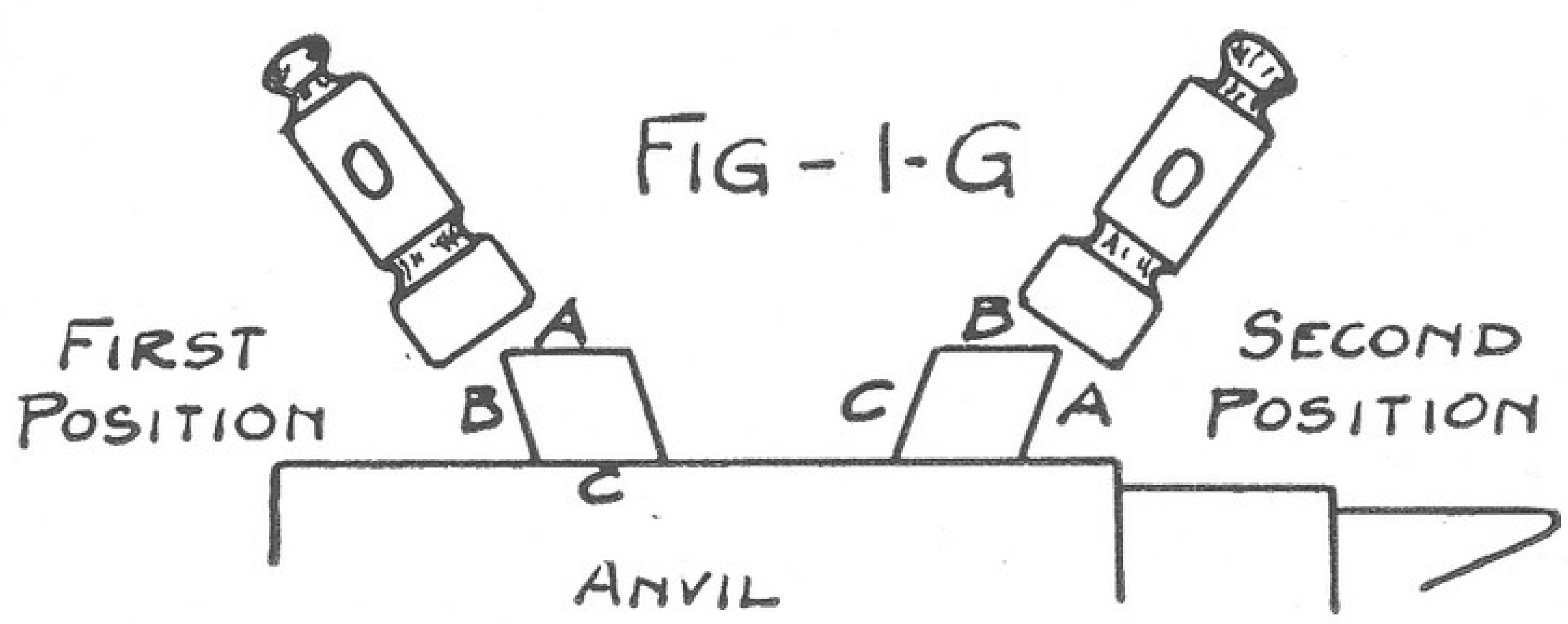


FIG-1-G



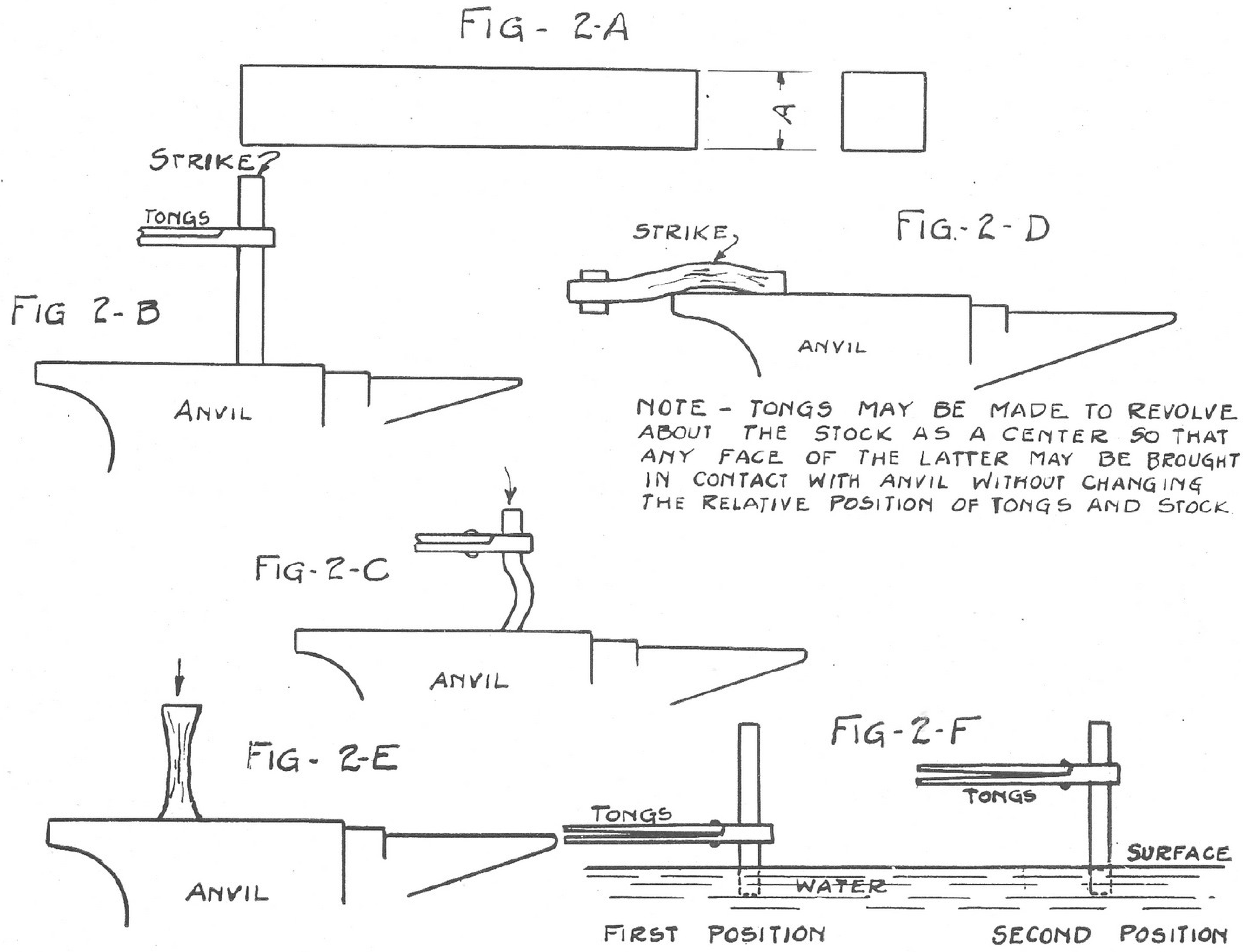
Exercise No. 2

Stock—Norway Iron—½″ x ½″—5″ long.

EXPLANATION—Stock is to be upset to 3″ in length. The finished piece, Fig. 2 A, must be sound, must be square and uniform in section. True to size, straight, and smooth.

OPERATION—The stock having been brought to a white heat, blows are to be delivered as shown by Fig. 2 B. One result of such blows is illustrated by Fig. 2 C. The stock may be straightened without changing the tongs, Fig. 2 D, or the tongs may be changed to one end. A second result of blows, Fig. 2 B, is shown by Fig. 2 E. This may be overcome and the piece upset evenly, by slightly cooling the ends, Fig. 2 F.

CAUTION—Do not work the stock after it has cooled to a bright red heat. Strike true or the stock is likely to fly from the tongs, endangering your own safety and the safety of others. Do not attempt to straighten unless the stock is hot. In straightening be sure that the work beds well on the anvil before striking it, otherwise it is likely to fly. Do not take so much time in cooling that, Fig. 2 F, the body of the stock will become cool.



Exercise No. 3

Stock—Norway Iron—½″ diameter—6″ long.

EXPLANATION—A round section is to be drawn to a square; a square to an octagon; and an octagon to a round point.

The finished piece must agree with the drawing, Fig. 3 A, in form and dimensions.

OPERATION—Square one end of stock (see Fig. 3 D), make center punch mark 2″ from squared end. After heating with squared end of stock in tongs, bring center punch mark over edge of anvil and strike one blow, Fig. 3 B. Turn the stock through an angle of 90° and strike a second blow, Fig. 3 C. Draw the stock to a square section as shown by Fig. 3 D.

Lay off center punch mark 4″ from squared end, and proceeding as before, produce the form, Fig. 3 E.

Lay off center punch mark 6″ from squared end and draw the point first to a square, Fig. 3 F, and then to a round, Fig. 3 G. If there is excess of stock cut it off on the hardy, Fig. 3 H.

CAUTION—Do not let the shoulders, Fig. 3 E, cover the punch marks. Better form them a little in front of the mark and draw them back to it.

When rounding the point turn the stocks; turn the stock first in one direction then in the opposite, otherwise the point will be twisted off. The point will split if drawn at too low a heat.

FIG.-3-A

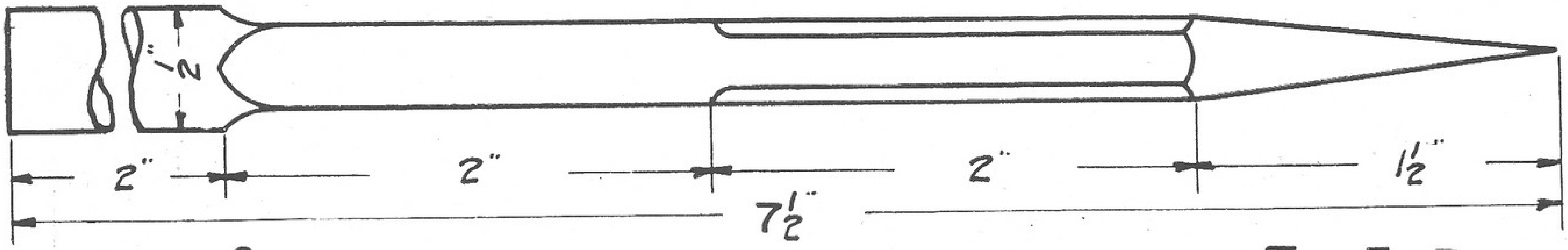


FIG-3-D

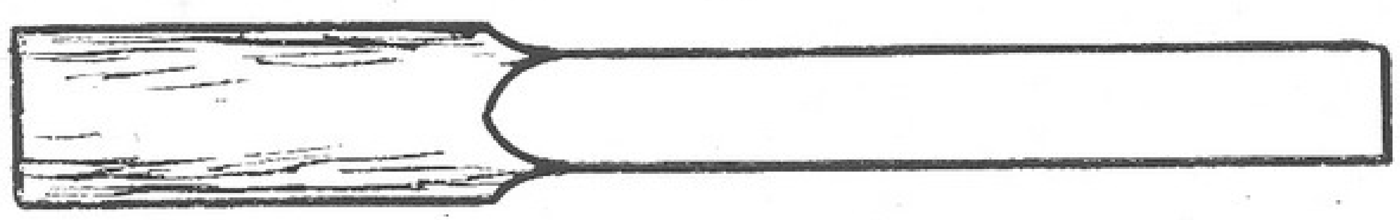


FIG 3 B

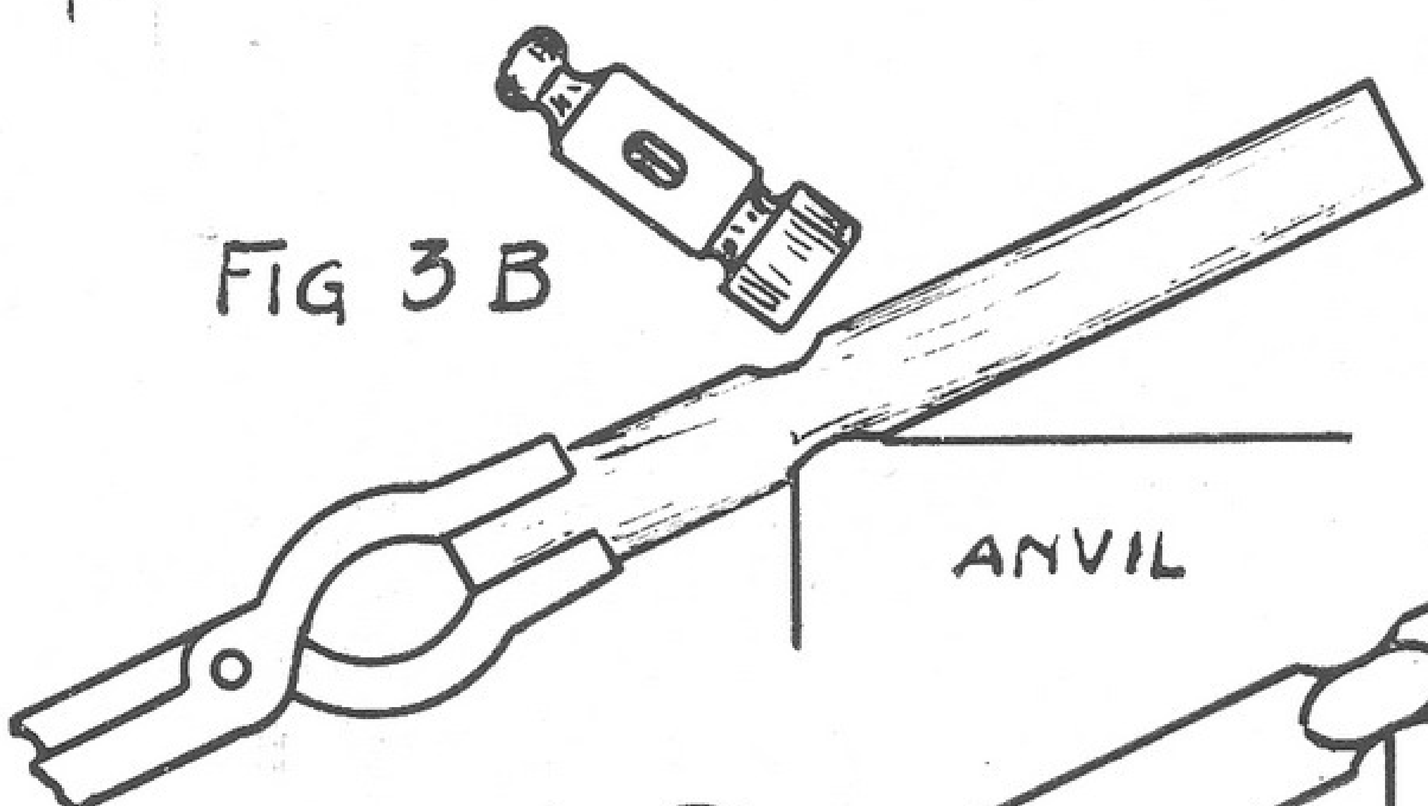


FIG-3-C

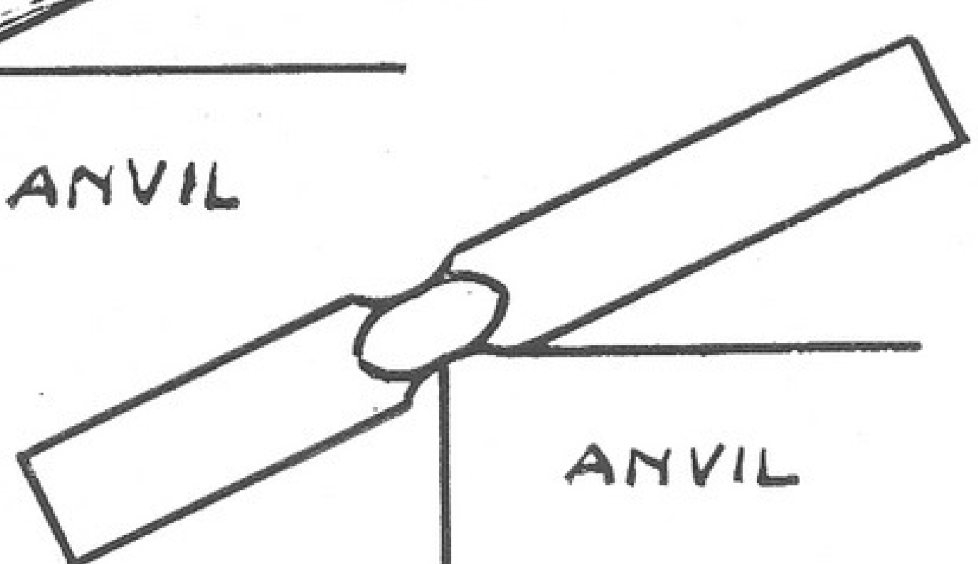


FIG-3-E

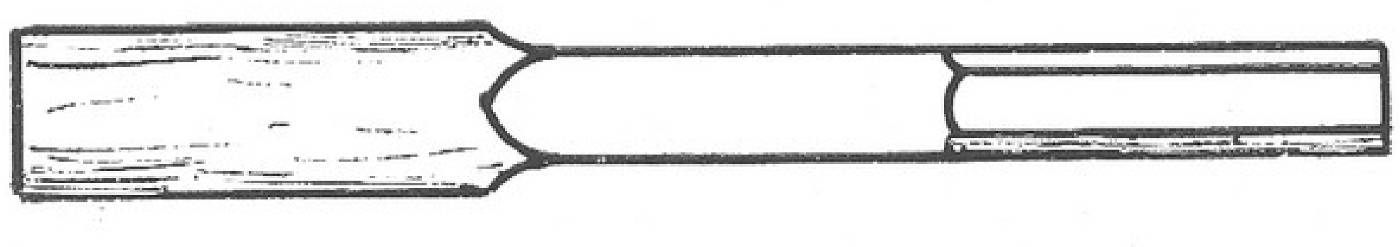


FIG 3-F

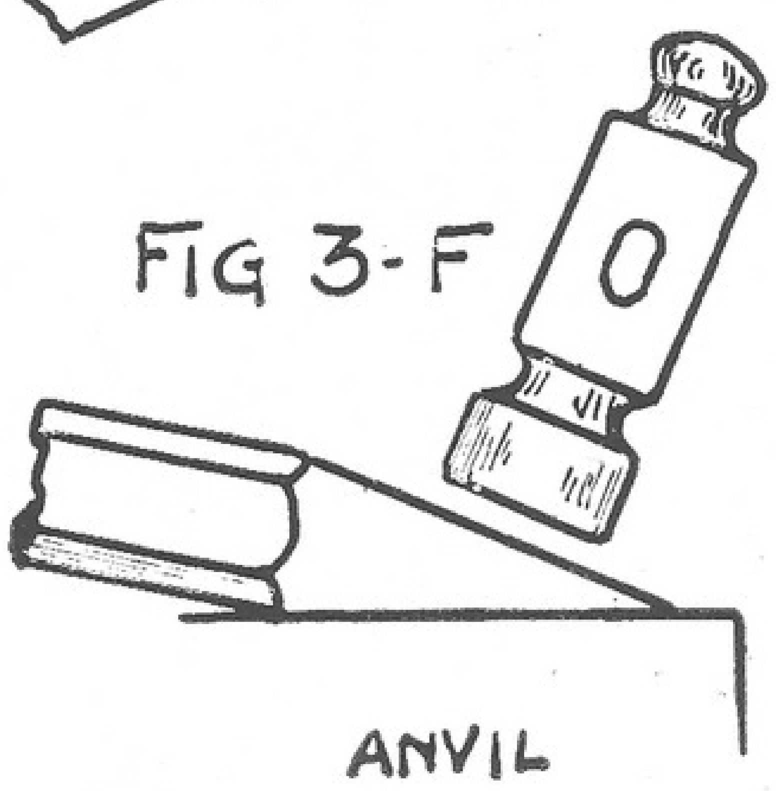


FIG-3-G

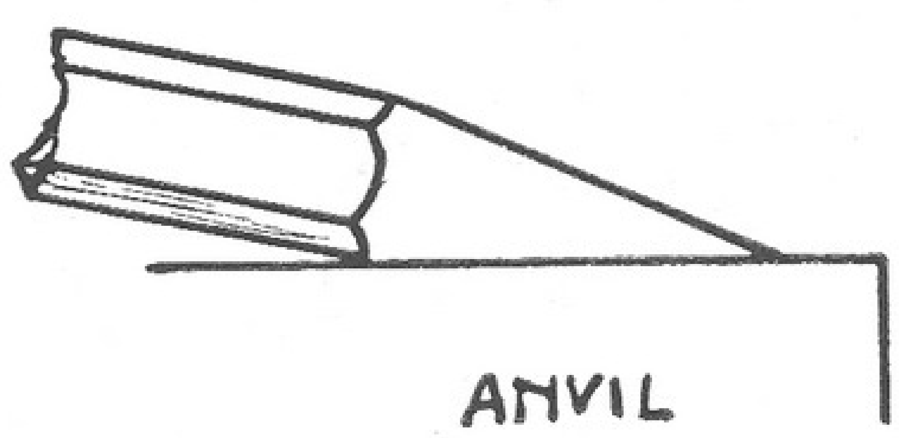
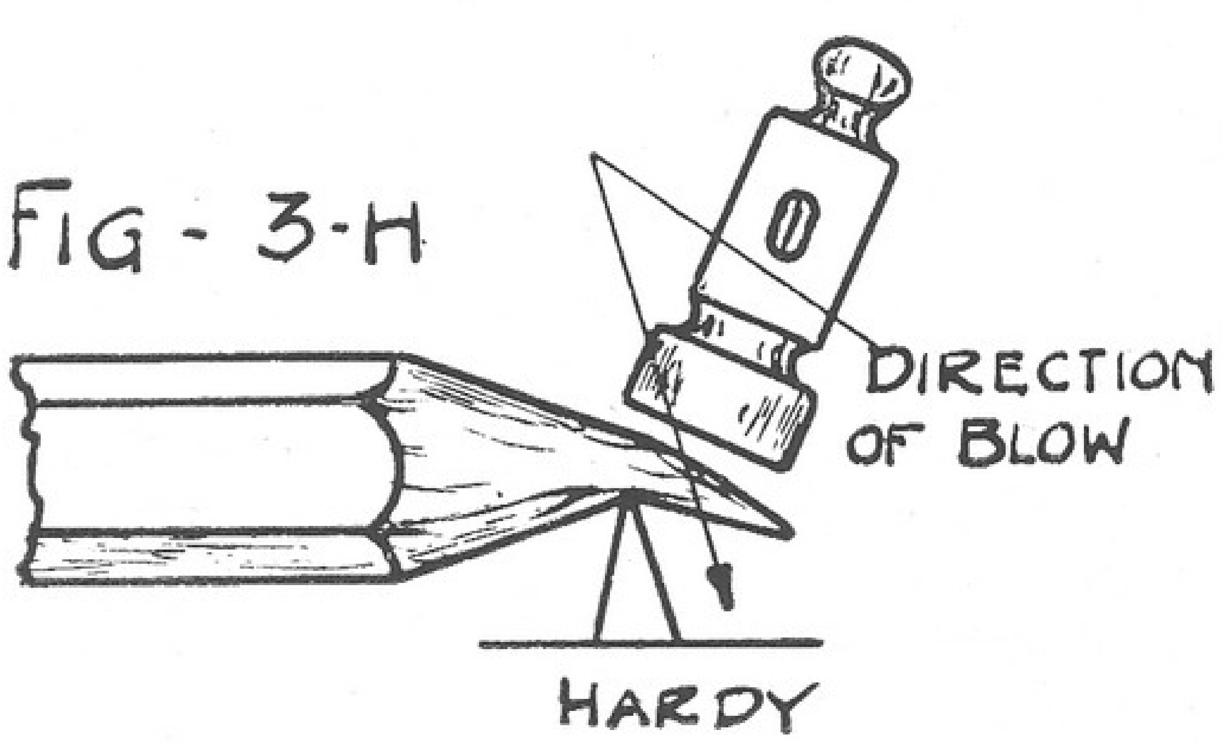


FIG-3-H



Exercise No. 4

Stock—Norway Iron—½″ diameter—5″ long.

EXPLANATION—A piece of ½″ round stock is to be upset until a portion of its length is large enough to form a ½″ square. The finished piece must agree with the drawing, Fig. 4 A.

OPERATION—Make a center punch mark 2″ from one end and heat from end to punch mark. Apply the tongs to the side of the stock before taking the latter from the fire. If the portion heated is too long, cool to punch mark, Fig. 4 C. In any case cool the extremity of the heated end slightly, to avoid the effect illustrated by Fig. 2 F. Strike as shown by Fig. 4 B. Continue to upset until the enlarged portion is about ⅝″ in diameter, Fig. 4, then draw to a square. If when down to size, the corners are not sharp, upset again. By drawing they will become sharp. The square portion completed, finish the opposite end, *A*, Fig. 4 B.

CAUTION—If it is necessary to cool the stock to the punch mark, Fig. 4 C, give it a very slight up end motion, so that the change from hot to cold may not be too abrupt. Otherwise the stock is likely to crack on the line of the surface of the water.

FIG 4-A

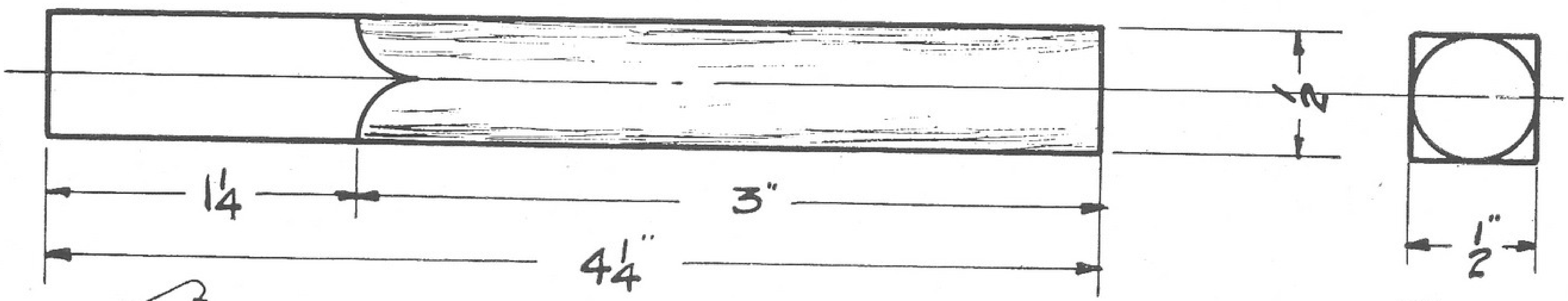
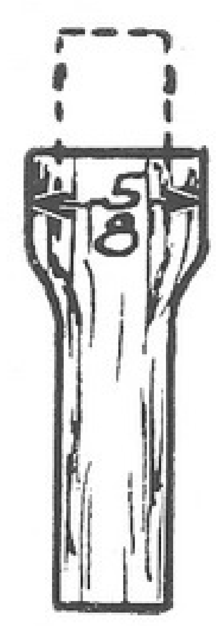


FIG-4-



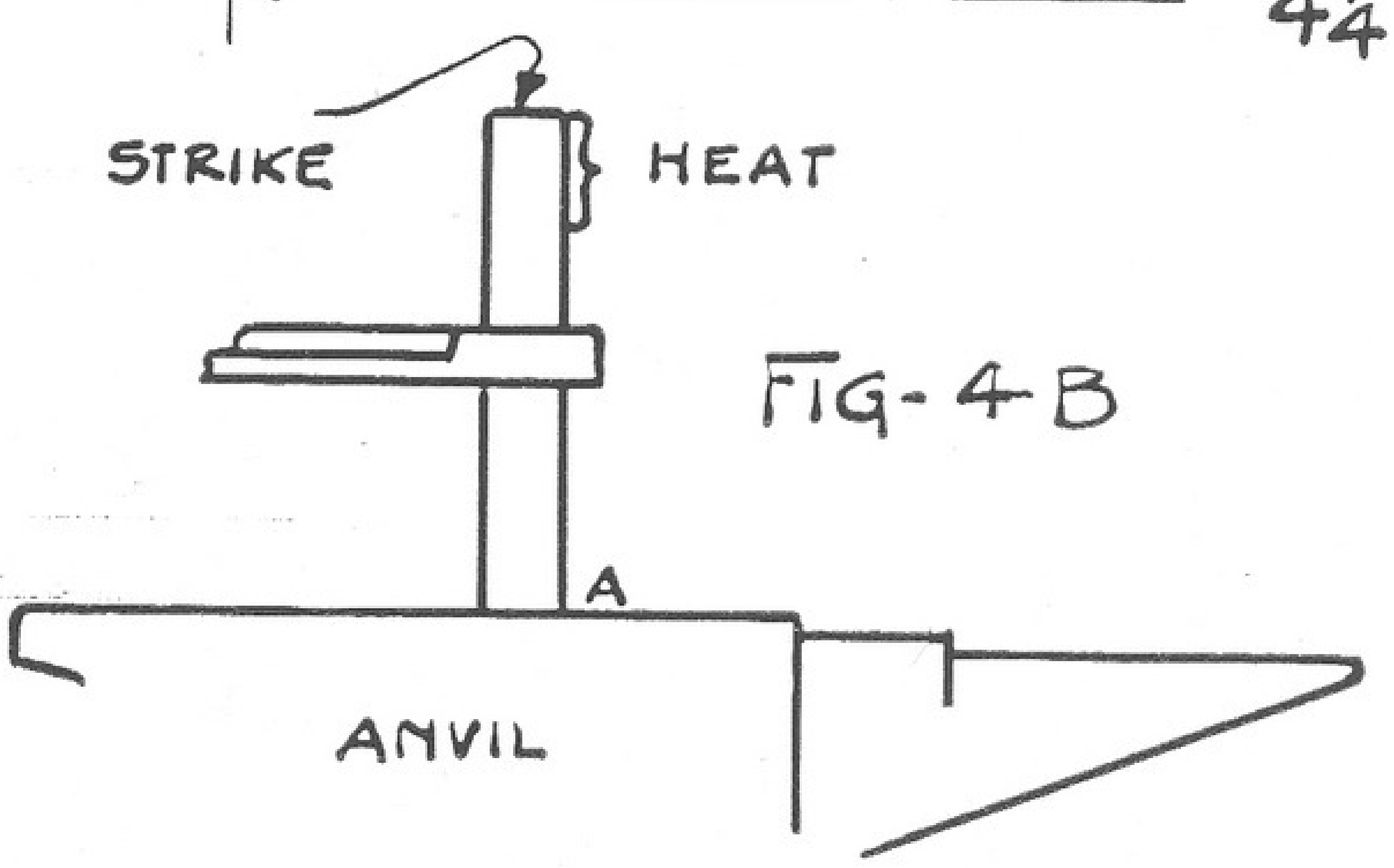
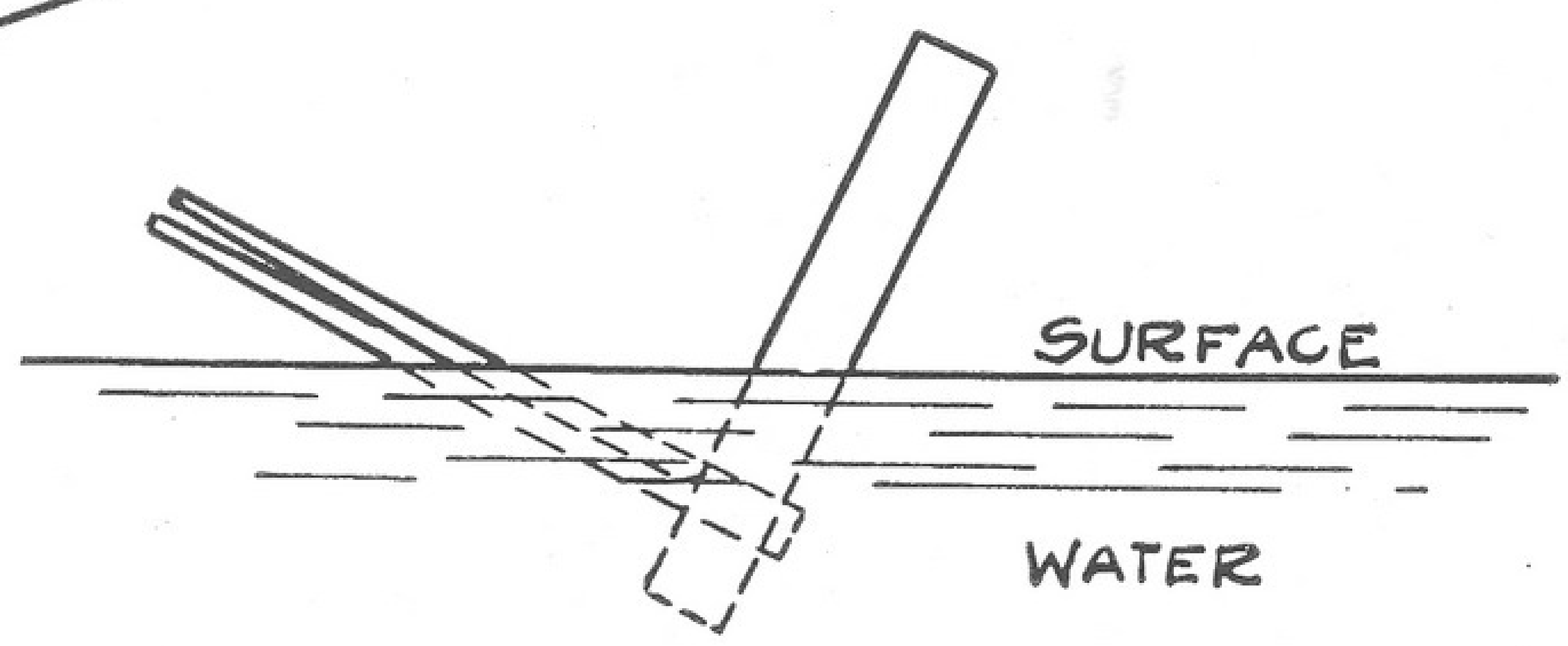


FIG-4-B

FIG-4-C



Exercise No. 5

Stock—Common Iron—¼″ diameter—8¼″ long.

EXPLANATION—A piece of ¼″ stock is to be bent to a circle. The finished piece, Fig. 5 A, must be free from hammer marks, as nearly a true circle as possible, and "out of wind."

The blacksmith's rule for finding the length of stock for an unwelded ring is "3 x inside diameter + 3 x width of stock": In this case, (3 x 2½″) + (3 x ¼″) = 8¼″. If the ring is to be welded, one half the thickness is added. This rule applies to rectangular sections as well as to round sections. For example, suppose the ring, Fig. 5 B, is to be made. The necessary stock will be 3 x 3″ (inside diameter) + 3 x ¼″ (width) + ½″ (half the thickness) = 10¼″.

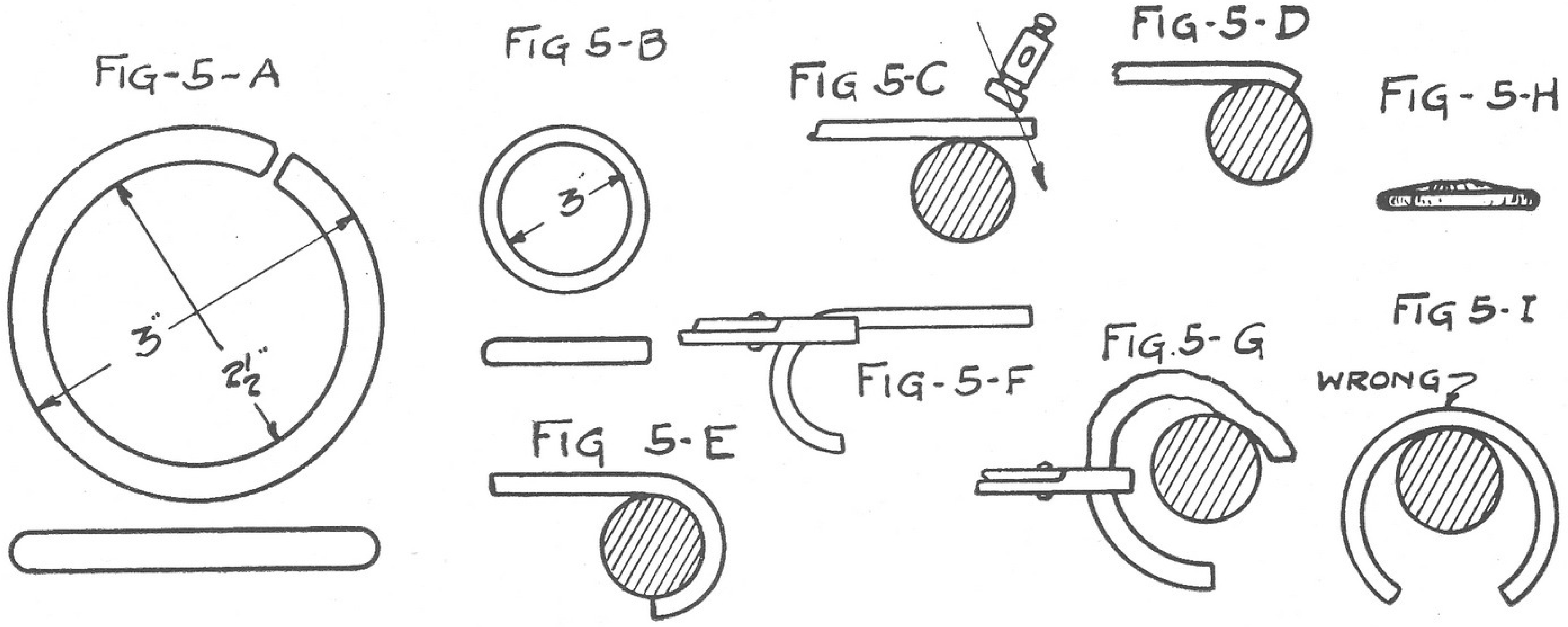
OPERATION—Heat to a cherry red about half the length of the stock. Allow the end of the heated portion to project about ⅜″ over the horn, and strike as shown by Fig. 5 C, with the effect shown by Fig. 5 D. Advance the stock over the horn after each blow until half the stock is bent, Fig. 5 E. Change the stock in the tongs, Fig. 5 F, and repeat the operation. The result will be a ring more or less round.

An examination will show that some portions of the stock are bent too short, while others are not short enough. To unbend the stock when the curve is too short, strike as shown by Fig. 5 G.

Having completed the ring as seen in plan, examine it in elevation. If it is "in wind" it will appear as shown in Fig. 5 H. To get the ring out of wind hold it flat on the face of the anvil and strike with light blows, the *low parts* which will then seem to rise to the lever of the adjoining portions.

CAUTION—As there is no opportunity to smooth the work by hammering, the stock must not at any time be heated hot enough to scale.

Never strike the stock directly over the horn, Fig. 5 I, as such blows can have no bending effect.



Exercise No. 6

Stock—Norway Iron—3/8″ x 3/8″—5 5/8″ long.

EXPLANATION—The finished piece must be smooth and must agree with the form and dimensions shown by Fig. 6 A.

OPERATION—Lay off punch marks as shown by Fig. 6 B. Guided by marks, draw the stock to the form shown by Fig. 6 C. To bend the large eye, Fig. 6 A, first set the stock back as shown by Fig. 6 D, then begin at the end and bend, Fig. 6 E.

The small eye, Fig. 6 A, is to be formed in the same way. To twist the body, heat between the punch marks *C* and *D*, Fig. 6 B, to an even dull red, drop one end of the stock in the vise to the punch mark *C* and apply the tongs at the punch mark *D*, all as shown by Fig. 6 F; then carry the tongs once around and the twist will be made.

CAUTION—In setting back the stock, Fig. 6 D, be careful that the blows do not fall directly over the horn; unless care is exercised the stock will be reduced at *E*, Fig. 6 D.

After the stock has been fastened in the vise for twisting, the operation must go on rapidly; if too much time is taken the vise will absorb heat from the stock and the twist will be uneven.

FIG - 6 - A

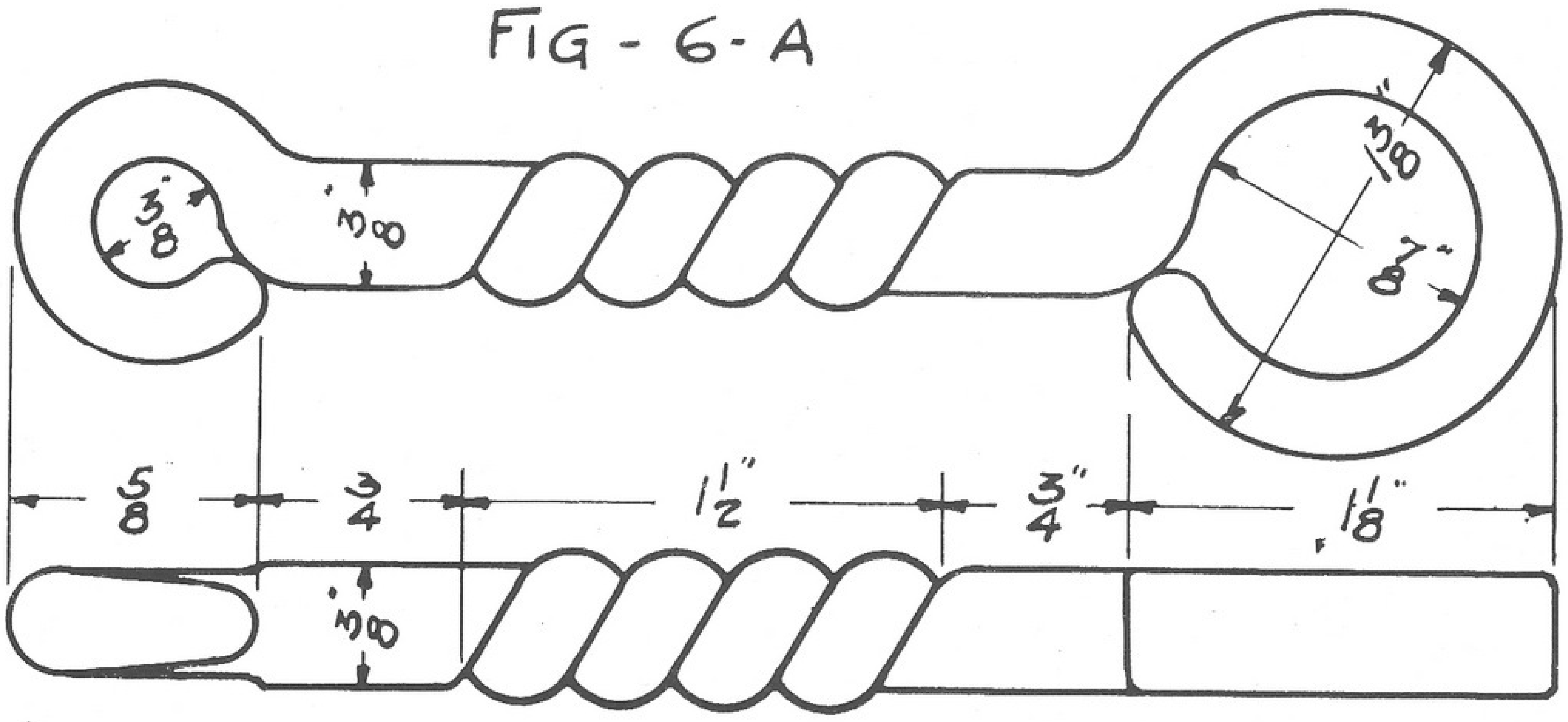


FIG - 6 - B

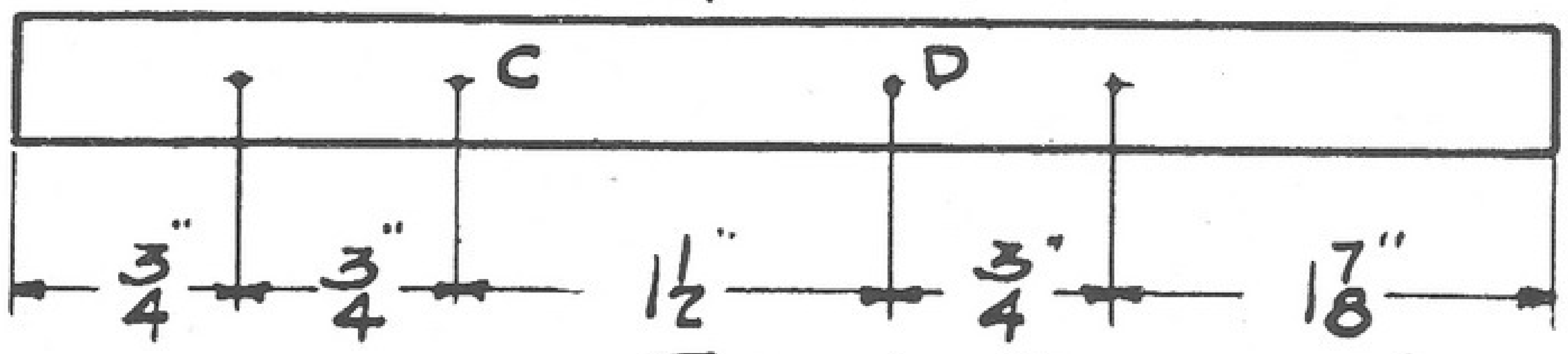


FIG - 6 - C

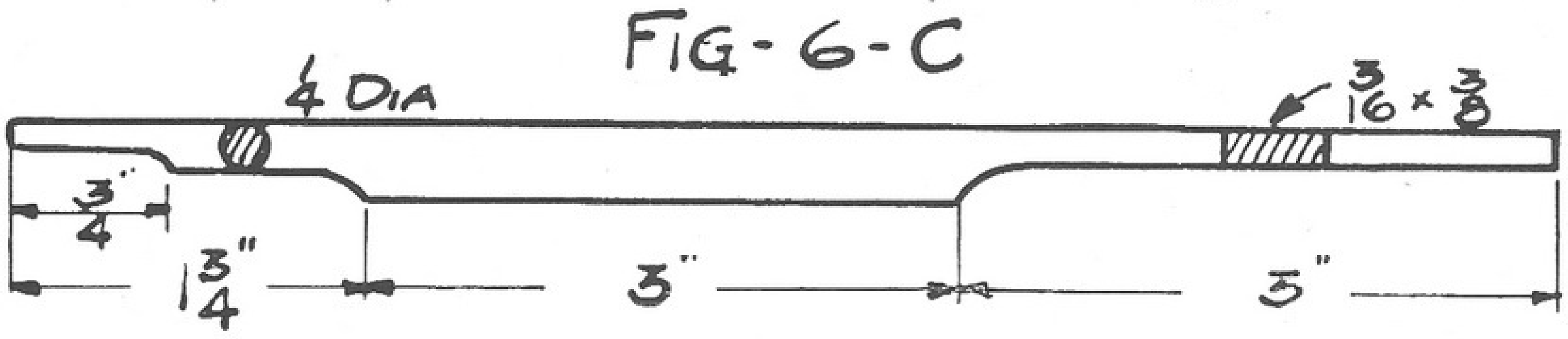


FIG 6 - D

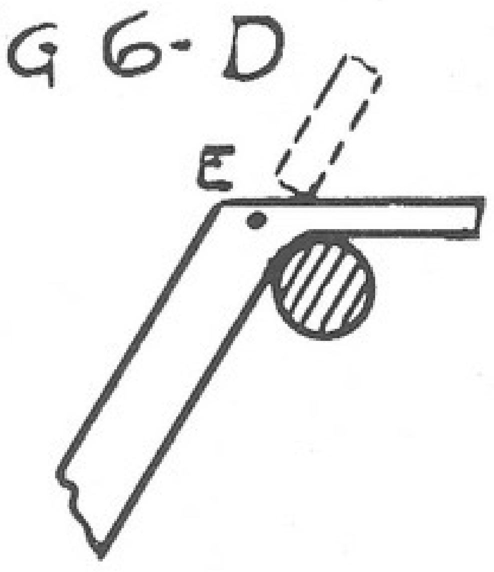
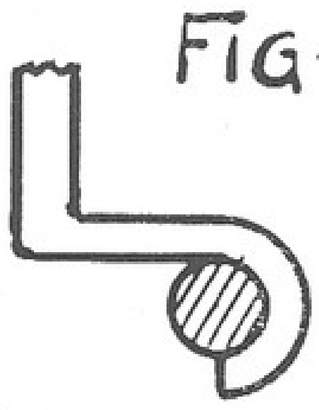


FIG - 6 - E



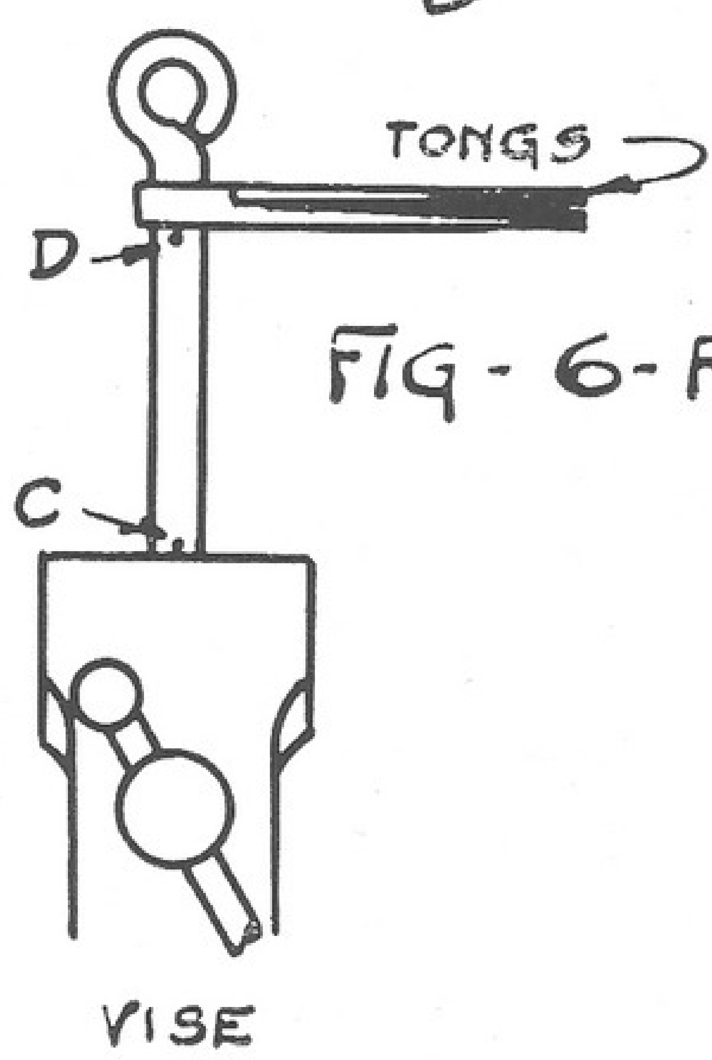


FIG - 6 - F

Exercise No. 7

Stock—Norway Iron—$\frac{3}{8}$" x 1"—Convenient length.

EXPLANATION—The stock is folded to form three thicknesses, Fig. 7 H, which are to be welded together. The welding finished, the welded portion is to be cut off and brought to the form and dimensions shown by Fig. 7 A.

OPERATION—Lay off center punch marks *A* and *B*, Fig. 7 B, and repeat *B* on opposite face. With the stock at the point *A*, at a white heat carry it over the rounded edge of the anvil, Fig. 7 C, and bend first by striking at *D*, Fig. 7 C, and then at *E*, Fig. 7 D, and so on until the form, Fig. 7 E, is produced. Next strike Fig. 7 F, producing the form, Fig. 7 G.

Guided by the punch mark *B* and operating as before, produce the form, Fig. 7 H.

Secure a welding heat over the whole piece and strike with heavy blows as shown by arrows, Fig. 7 H. Stop striking the instant the stock has cooled below a welding heat. Before taking a second welding heat, pein the joints between the layers as shown along *GH*, Fig. 7 I. The joints on both faces having been peined, take a second welding heat and after delivering two or three blows as shown by the arrows, Fig. 7 H, turn the work and deliver the blows on the edges, Fig. 7 J.

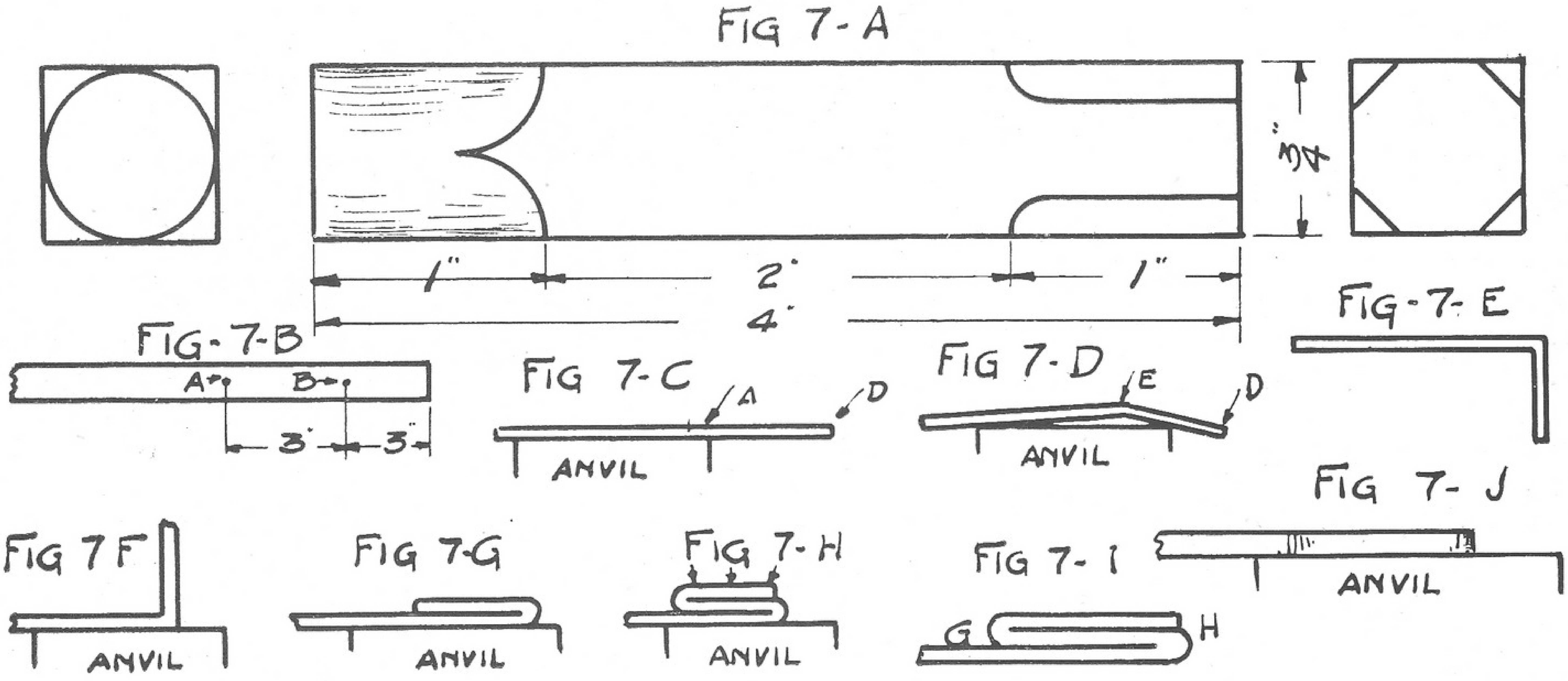
When the welding is completed, draw the piece to $\frac{3}{4}$" square; cut off the ragged ends, making the stock $3\frac{7}{8}$" long.

Locate a punch mark 1" from each end and draw to the form shown by the finished piece, Fig. 7 A.

If, after welding, the stock is less than $\frac{3}{4}$" square, allowance must be made for upsetting, before cutting it off.

CAUTION—Be sure that the welding heat is where it is wanted and that the different pieces to be welded are equally heated.

Remember that every blow delivered after the welding heat is gone unnecessarily reduces the stock which is thus likely to come "undersize" before it is finished.



Exercise No. 8

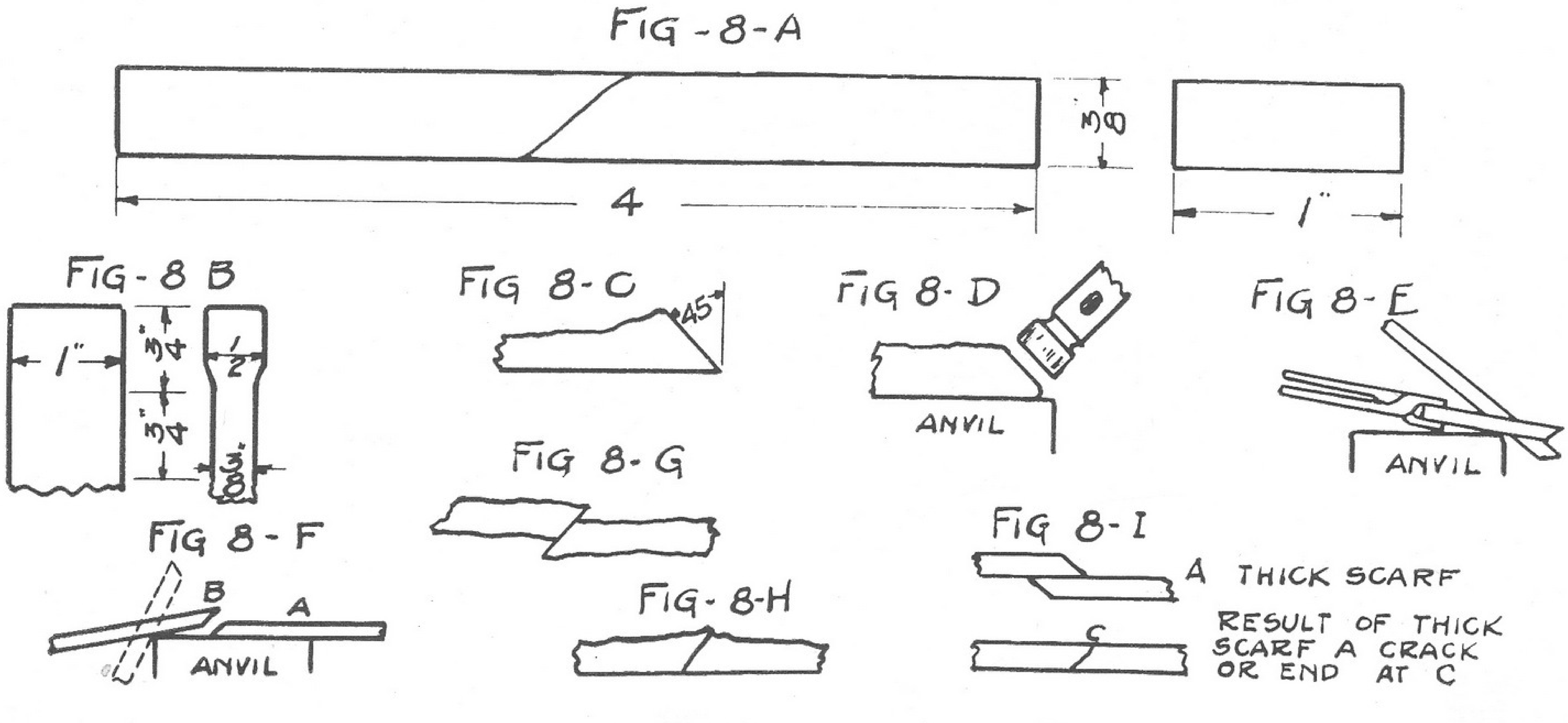
Stock—Norway Iron—1 Piece $\frac{3}{8}''$ x 1″—3″ long.
1 Piece $\frac{3}{8}''$ x 1″—Convenient length.

EXPLANATION—A three-inch piece is to be welded to the end of a longer piece, forming a "scarfed weld." The welded portion is to be cut to length and finished as shown by Fig. 8 A.

OPERATION—The finished piece is to be of the same cross section as the stock. The latter must therefore be upset enough to make up for waste in welding, Fig. 8 B. The proper form of scarf is shown by Fig. 8 C. To produce it carry the stock to the edge of the anvil and draw as indicated by Fig. 8 D, striking on the edges as much as may be necessary to keep them from spreading beyond the width of the stock. The scarfed ends of both pieces having been brought to a welding heat they are to be "stuck" as follows: First, with the tongs holding the shorter piece in the right hand, and the longer piece of stock in the left hand (the scarfs of both being down in the fire) draw both out and give them a sharp rap on the anvil, Fig. 8 E, to remove coal, etc., from the surface of the scarfs. Next bring the short piece to the position shown by *A*, Fig. 8 F, and follow with the longer piece to the position of the dotted outline *B*. Without losing contact between the longer piece and the anvil, bring *B* down upon *A* as shown. The contact with the anvil assists in controlling the movements of *B*. When *B* is once placed on *A*, a little pressure on the former will hold both in their relative position, while the tongs are dropped, Fig. 8 F (thus relieving the right hand) the hammer taken and a blow delivered in the direction of the arrow, Fig. 8 G. The amount the pieces should lap is shown by Fig. 8 G. As soon as the pieces are stuck the ends of the scarfs must be brought down, Fig. 8 H, and if thick must be peined out to the edge, shown by arrow, Fig. 8 H.

Draw to size ($\frac{3}{8}''$ x 1″); square the end beyond the weld, measuring from the squared end, cut the stock to length, and square the cut end.

CAUTION—Do not make the scarf too long, increasing their length increases the length of the portion to be welded. They are sufficiently long when they may be hammered down without cutting.



Exercise No. 9

Stock—Common Iron—½″ diameter—9″ long.

EXPLANATION—A piece of common iron is to be bent to a ring and welded. The finished work must agree with the form and dimensions shown by Fig. 9 A.

OPERATION—Upset the stock at both ends as shown by Fig. 9 B. If a scarf for round stock be made the same as for square or flat stock, Fig. 8 C, that of one piece will fold itself about the other piece so that in welding, the hammer must follow around the stock before all parts are reached: moreover, the effect of a blow on any portion of the scarf, Fig. 9 C, tends to spread other portions, as at *B*, away from the center of the work. These difficulties are avoided by making the scarf end in a point which may be easily covered by the hammer, Fig. 9 D, may be considered a typical form for round stock. It is best drawn by using the hammer on three faces only, as indicated by the arrows. The ends must be scarfed in opposite directions as shown by Fig. 9 E.

Bend the stock so as to bring the scarfs in the relative position shown by Fig. 9 F. Thus bent the piece may be welded entirely on the face of the anvil, after which it may be drawn to a uniform section on the horn.

To make the ring round, heat it to a dull red, press it as far up on the horn as it will go and turn it slowly while it is being lightly hammered.

CAUTION—Common iron cannot be worked at a low heat and it will not stand a very high heat. For upsetting it must be nearly to a welding heat. For welding it must be taken from the fire as soon as it is hot enough to stick.

FIG. 9-A

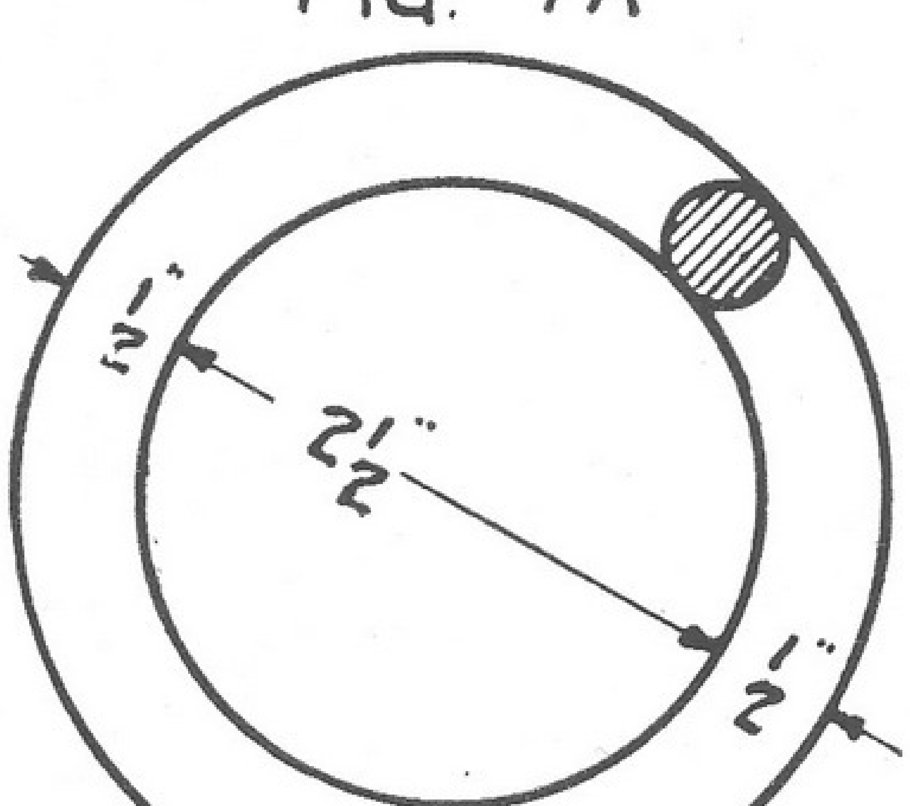


FIG 9 B

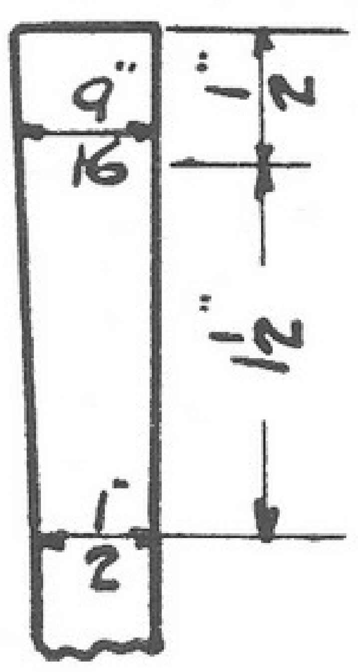


FIG. 9-C

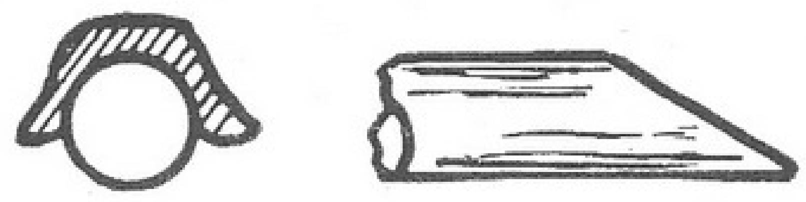


FIG 9 D

FIG- 9-F

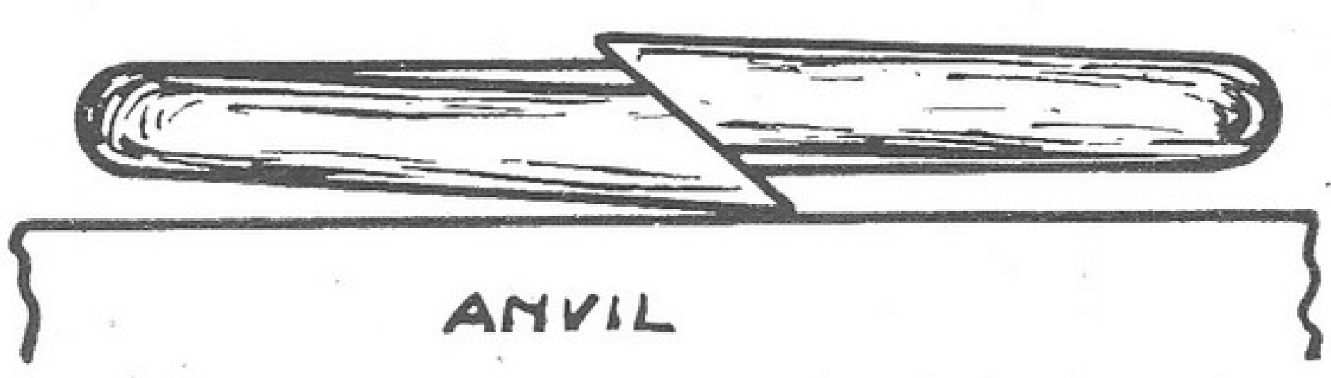
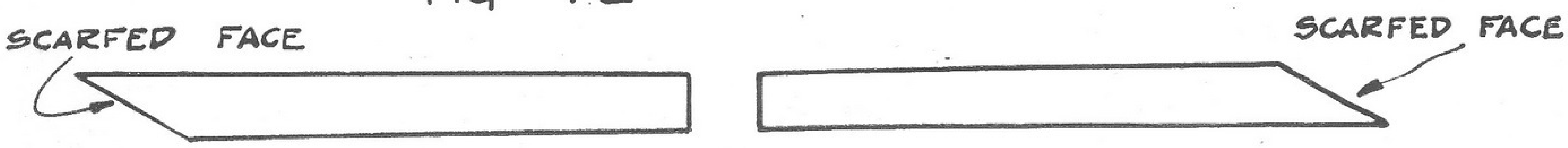


FIG 9 E



Exercise No. 10

Stock—Norway Iron—½″ x ½″—8½″ long.

EXPLANATION—It is easy to bend a piece of stock so that one part will stand at right angles with the other, but it is not easy to draw the stock to a sharp corner as in Fig. 10 A. This is the essential feature of the exercise. The finished piece must be sound and square and must agree with the drawing in form and dimensions.

OPERATION—Heat the piece in the center; cool the ends and bend the sides to angle of about 110°, Fig. 10 C. Hold an end of the piece, *A*, in the tongs, and resting the other end, *B*, on the anvil, deliver a series of blows in the direction of the arrow *A*. Then hold the piece by the other end, *B*, and with the end *A* on the anvil, deliver blows as before. Such blows will tend to produce a surface as *CD*, Fig. 10 B, which may be worked down to meet each other. As the surfaces come to a corner, bend the sides in so that they will be at an angle of 90° at the same time the corner is formed. Cool the ends back about two inches every time after heating, to keep them in shape as much as possible. When the corner is square make the parts straight and square with each other. Square the ends, cutting them to length if necessary.

CAUTION—In drawing the corners do not, at first, have the angle any more acute than is shown in Fig. 10 C and do not at any time deliver blows directly down as indicated by Fig. 10 D. A mistake in either of these respects will result in a crack as indicated by Fig. 10 E. Moreover do not attempt to forge the inside corner sharp; a corner thus forged not only offers a starting place for a break when the finished forging is under strain, but in most cases the process of making starts the crack.

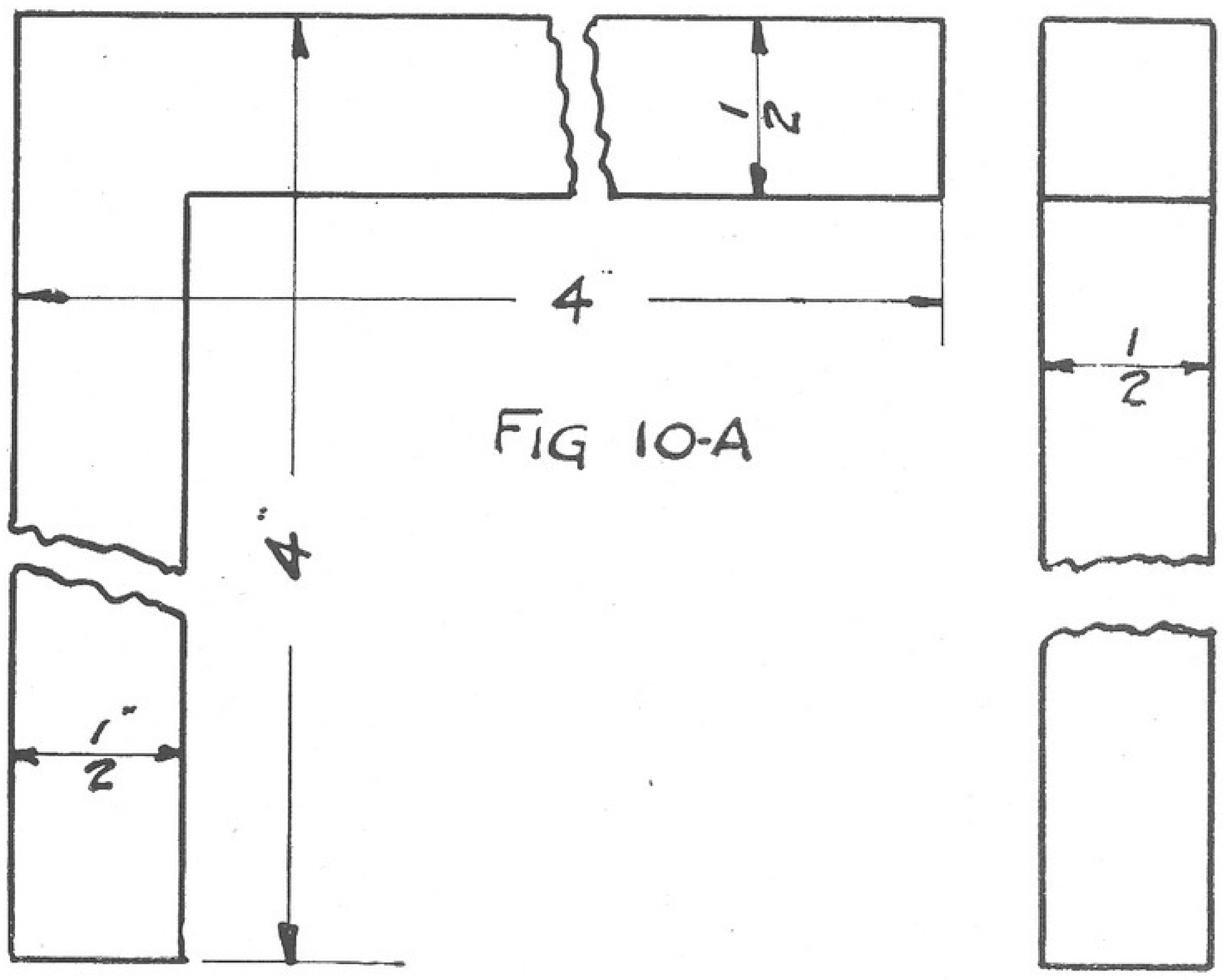


FIG 10-A

FIG 10-B

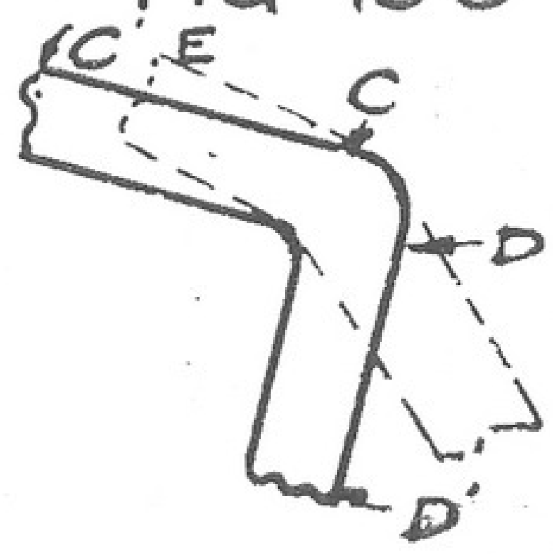


FIG 10-C

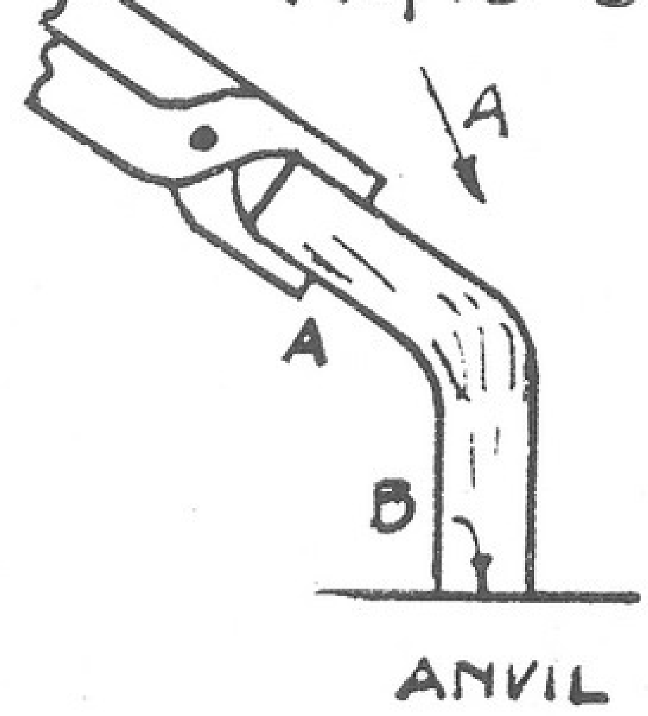


FIG 10 D

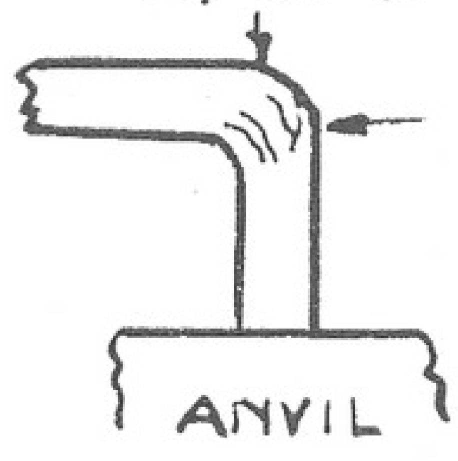
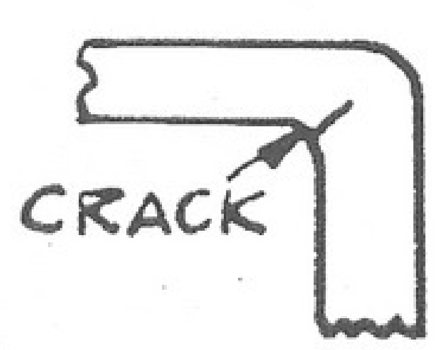


FIG 10 E



Exercise No. 11

Stock—Norway Iron—1 Piece $\frac{1}{4}''$ x $1''$—$3\frac{3}{4}''$
1 Piece $\frac{1}{4}''$ x $1''$—$4\frac{3}{4}''$

EXPLANATION—The exercise gives practice in welding two pieces at right angles with each other as shown by Fig. 11 A. The finished piece must be sound, must have a good weld and must agree with the drawing in form and dimensions.

OPERATION—Upset both pieces as shown by Fig. 11 B. In scarfing the important thing is to have such parts of each piece that are to lap on the other piece drawn to an edge so that there will be nothing on one piece to cut into the other. This will be better understood by reference to Fig. 11 C which shows the pieces scarfed. See also Fig. 11 D.

Before taking a welding heat, practice taking the pieces from the fire and placing them together. See 8 E and 8 F. When the weld is made, smooth and form to dimensions.

CAUTION—Be very sure that you stick the pieces in their proper relative position. Be sure to get the pieces scarfed as shown in Fig. 11 C, unless for a left hand person. In this case the scarfs must be opposite to these shown in Fig. 11 C, so that the piece "*Y*" may be held in the right hand and placed upon the piece "*X*."

FIG 11-A

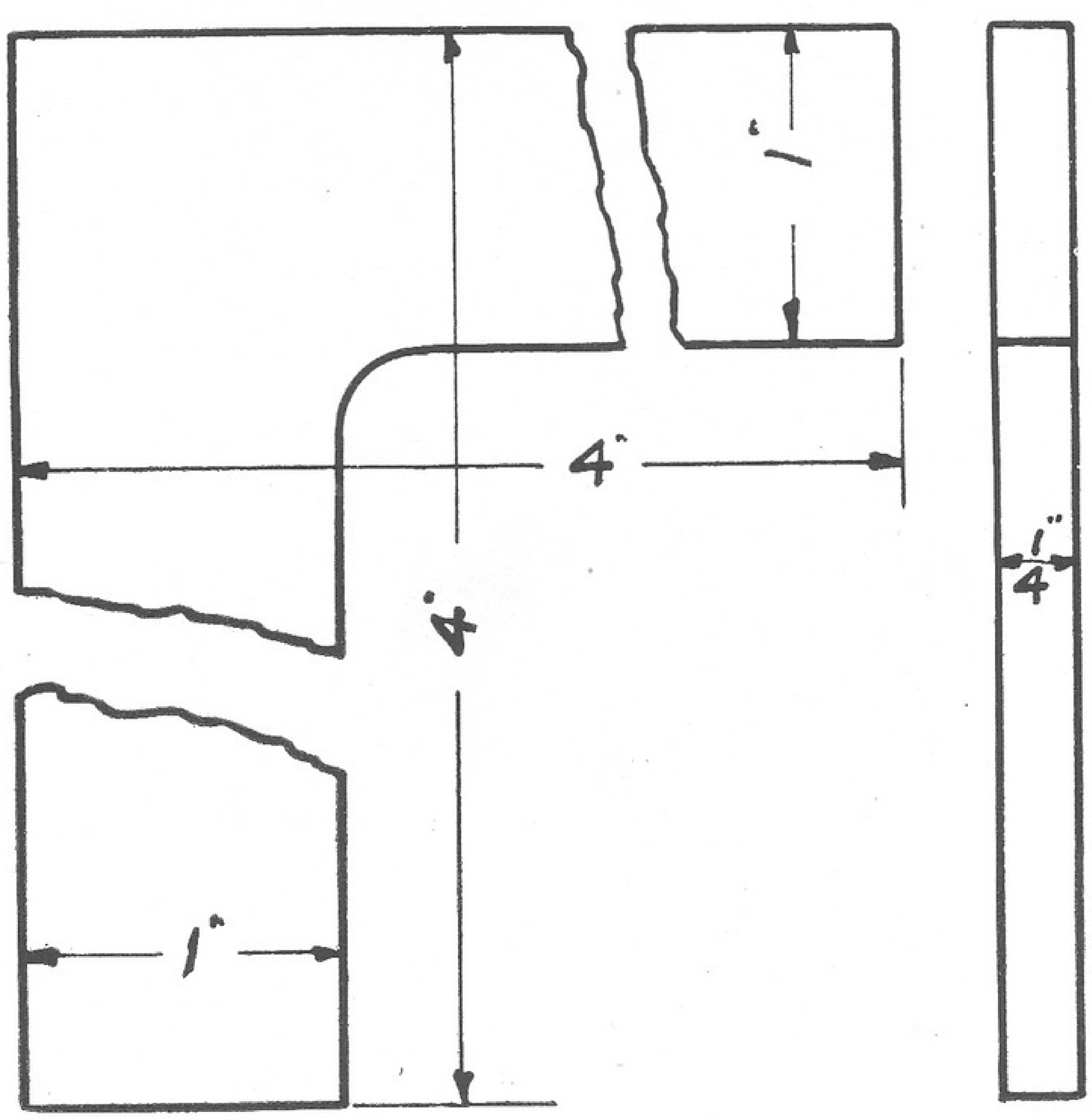


FIG-11-B

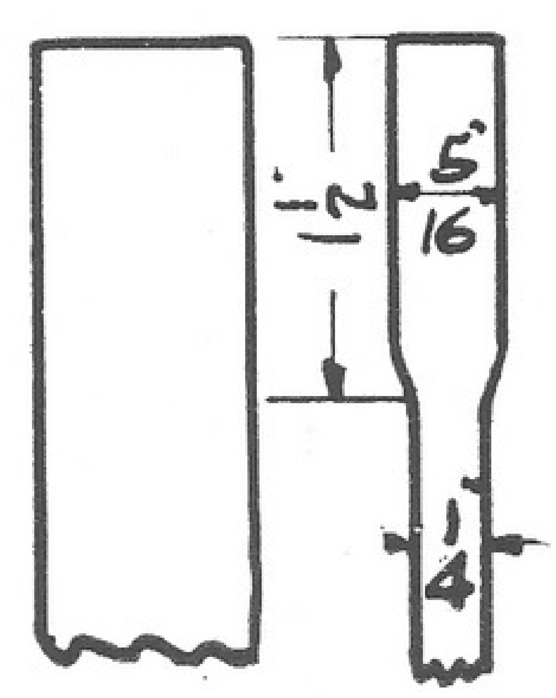


FIG-11-C

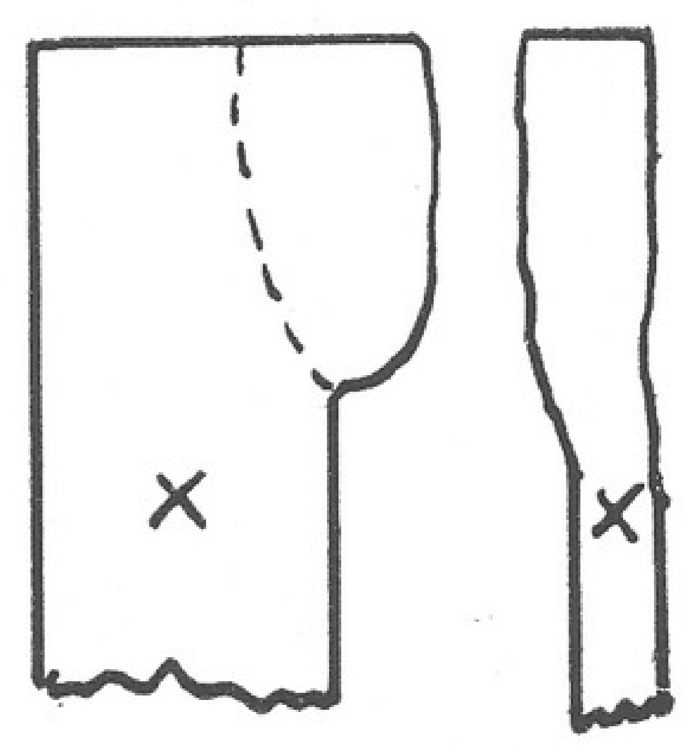


FIG 11-C

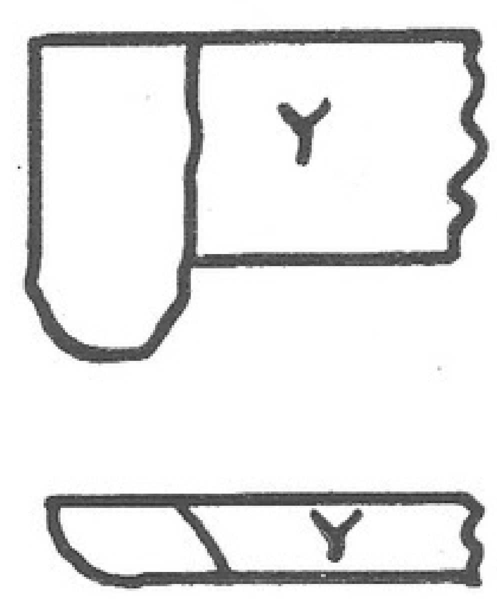
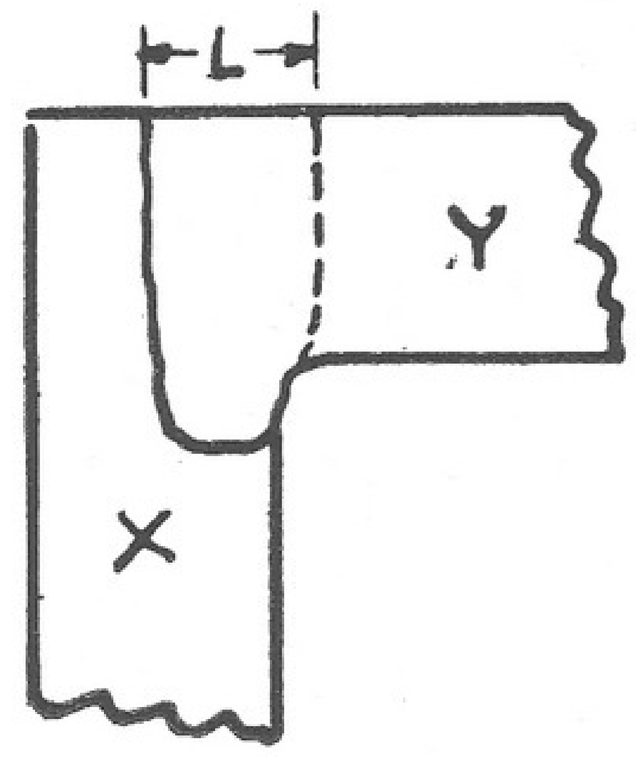


FIG 11 D
L = AMOUNT OF LAP



Exercise No. 12

Stock—Norway Iron—1 piece ¼″ x 1″—5″—called X
1 piece ¼″ x 1″—4″—called Y

EXPLANATION—This exercise, while similar to the preceding, is more difficult in heating and welding. The finished T should agree with the drawing, Fig. 12 A, in form and dimensions.

OPERATION—Upset *X* as shown by Fig. 12 B, and *Y* as shown by Fig. 12 C. Scarf as shown by Fig. 12 D. The pieces should be lapped for welding so that the points *A* will agree with points *A′*, Fig. 12 D.

CAUTION—Difficulty is experienced in heating *X* at the scarf, it being easier to heat the end. The fire should be small so that the end may be passed through it. If in spite of precautions taken the end does heat faster than the scarf, cool it before it reaches a welding heat.

FIG - 12-A

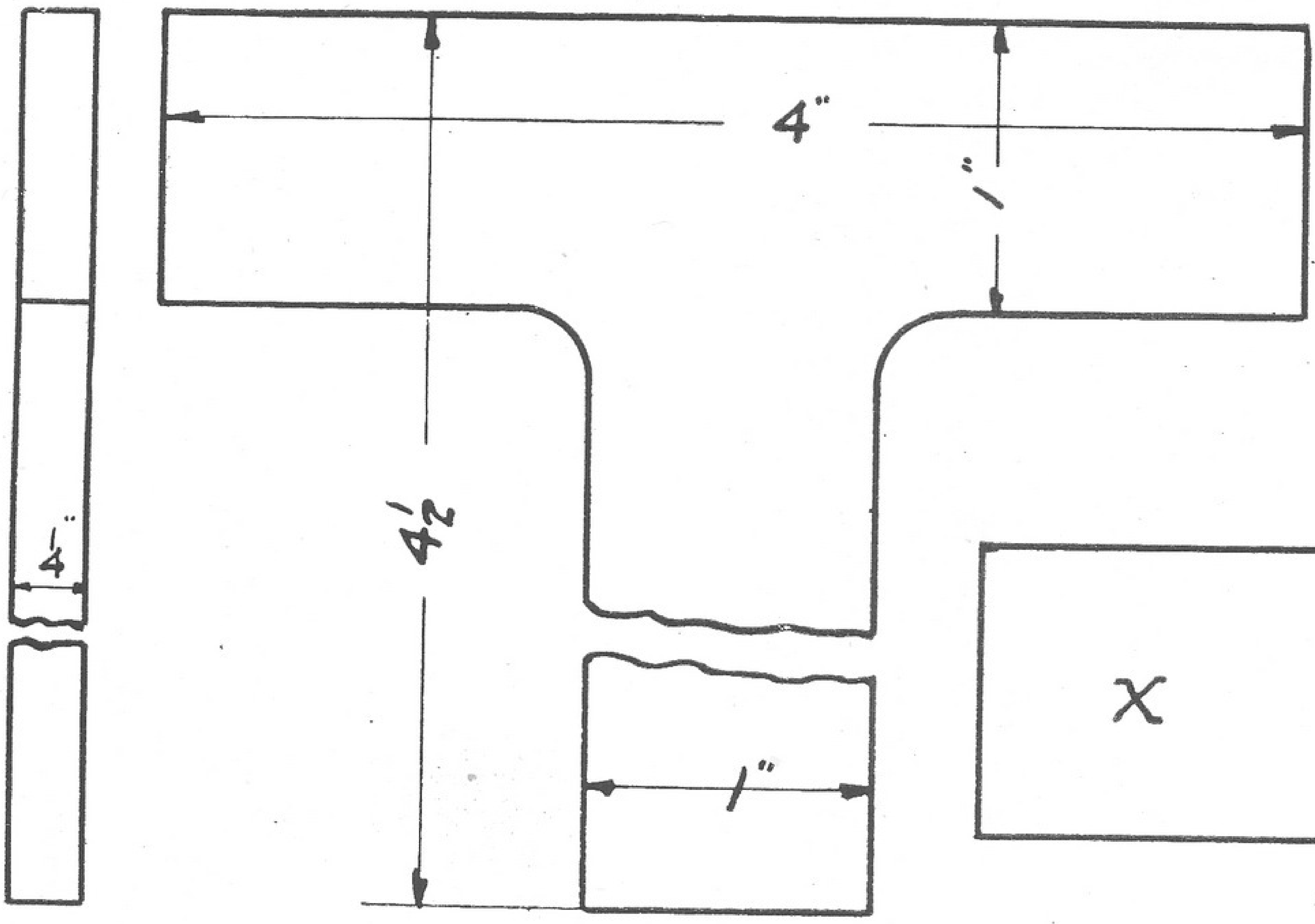


FIG 12-D

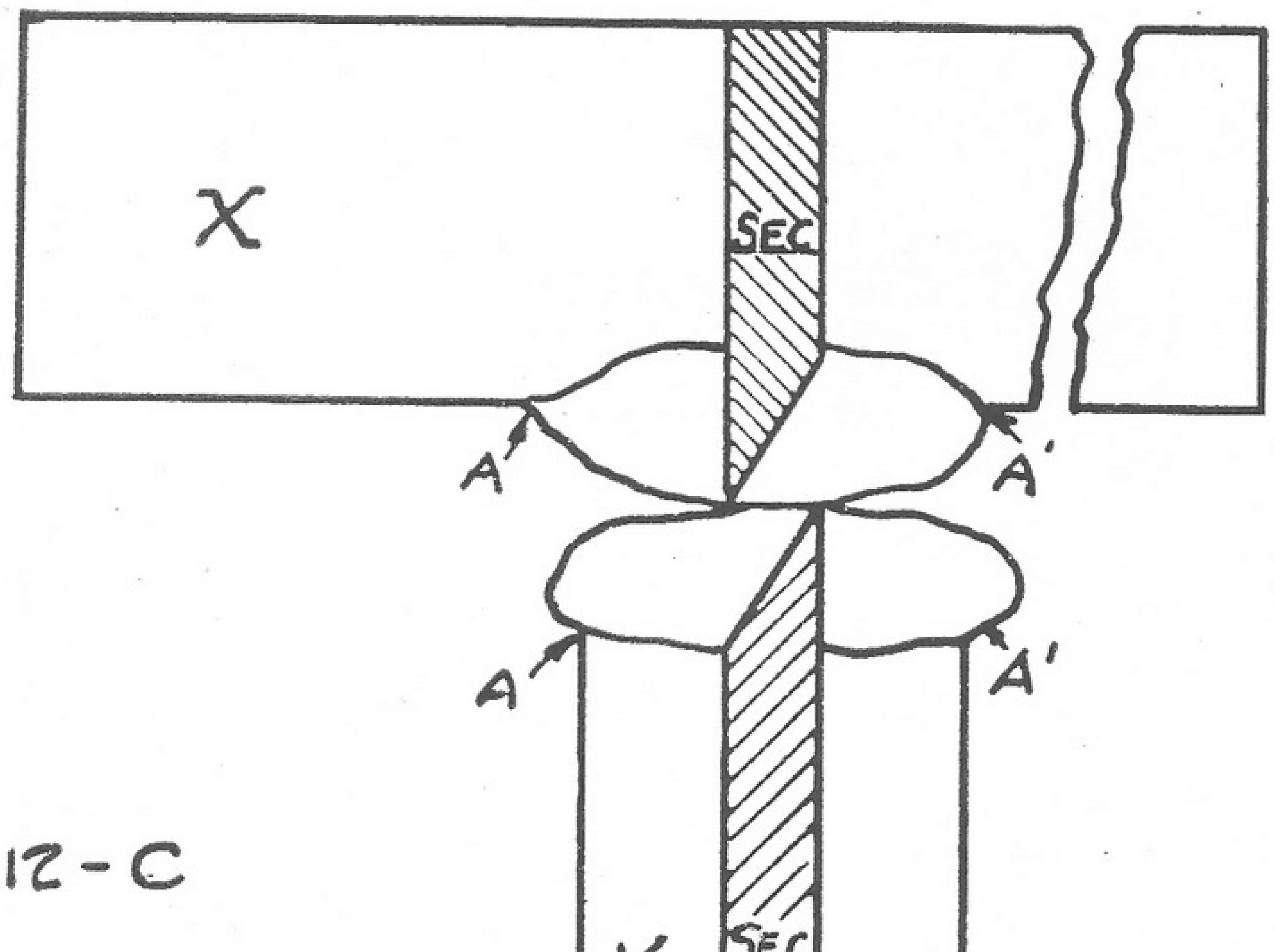
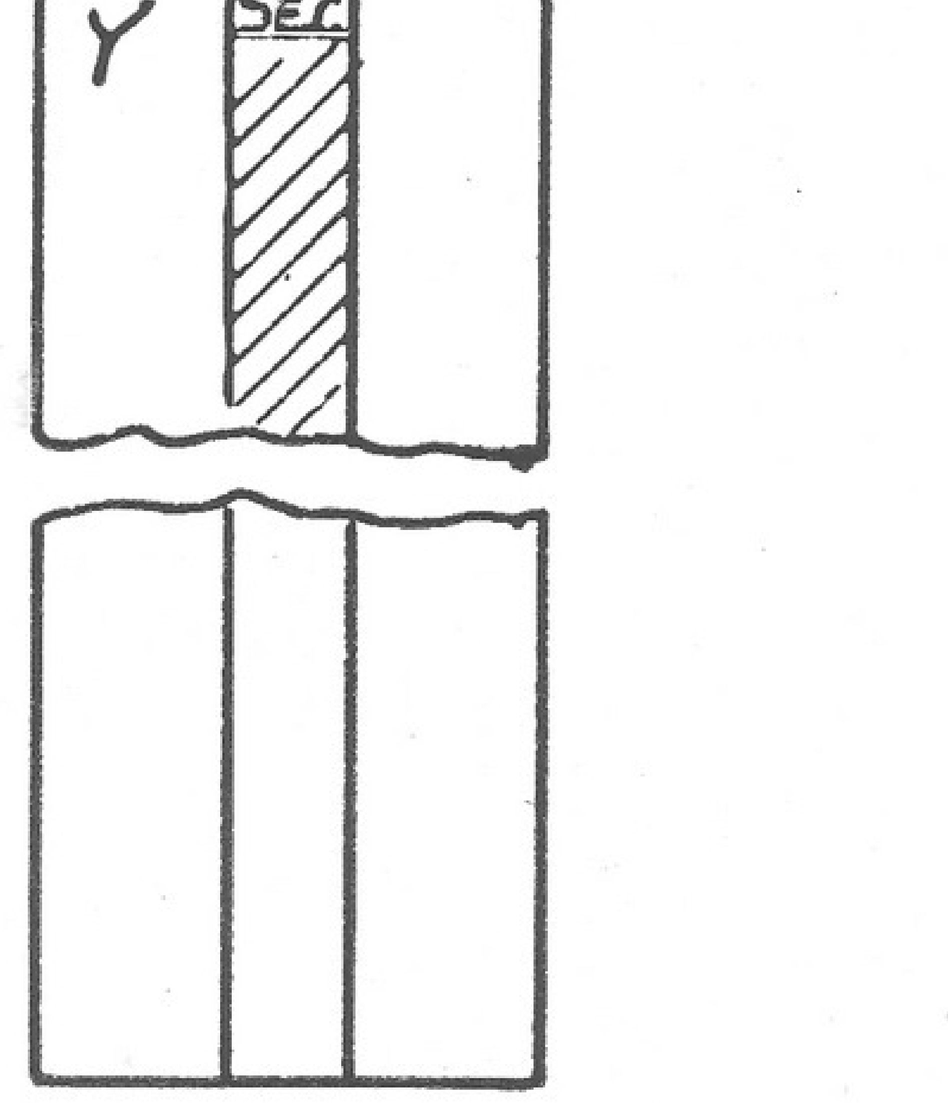



FIG 12- B

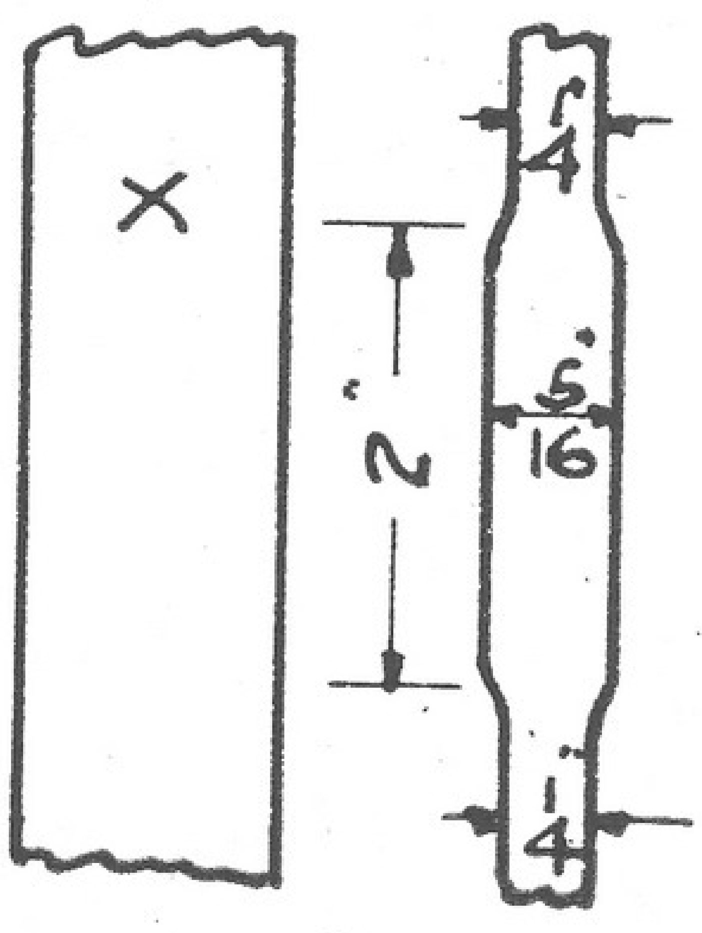
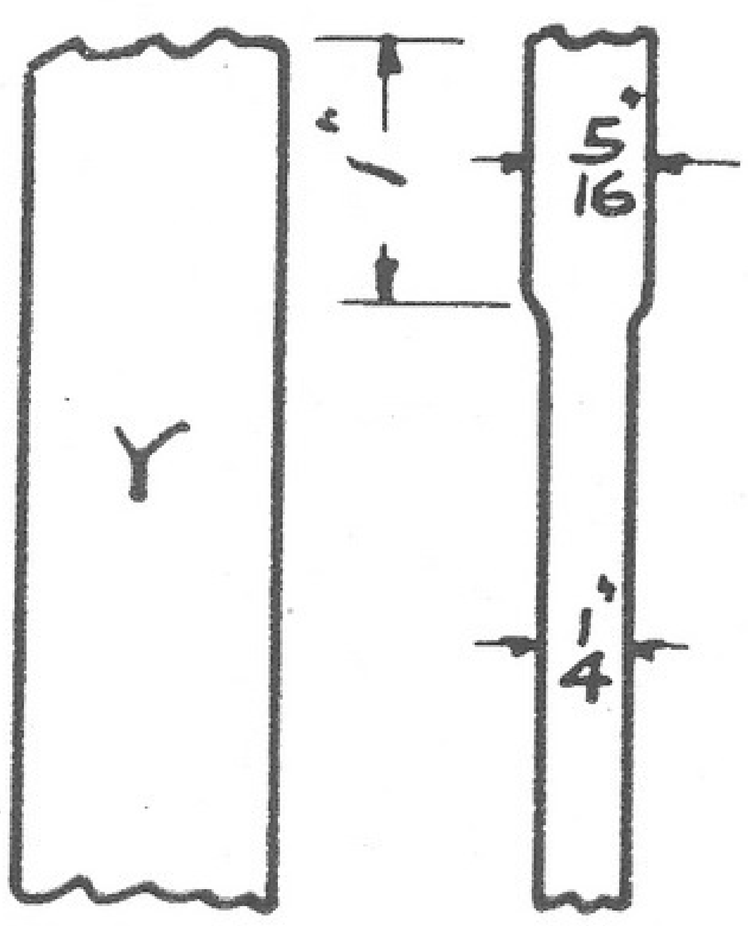


FIG 12-C



Exercise No. 13

Stock—Norway Iron—⅜″ x 1″—any length
Steel —⅜″ x 1″—4″

Welding steel to iron and steel to steel.

OPERATION—Draw the stock ¾″ x ½″ and scarf one end of each as for a scarf weld. Draw the iron 2″ from the end.

WELDING—When welding steel, borax is used as a flux, to prevent the steel from burning. Heat the iron to a red heat before putting the steel in the fire. When the steel becomes bright red put on the flux and replace it in the fire. Watch it carefully and when small white blisters are seen coming on its surface it is at the proper heat to weld; be sure that the iron is brought to the proper heat at the same time. After this weld is made scarf and punch the end of the steel as shown by Fig. 13 B and cut off 2¼″ from the end; scarf and punch the end from which the piece was cut off, rivet the pieces as shown in Fig. 13 C and it will be ready to weld. Weld and draw the whole piece to the form and sizes given in Fig. 13 A.

Steel Forging

THE FIRE—The fire should be kept clean and well banked; the coal should be well coked before the steel is put into the fire. Do not let the fire get hollow but keep a good bed of coals for the work.

HEATING—Keep the steel well covered with coals: heat slowly by using light draft. Turn the steel occasionally so that it may be heated evenly. Never heat hotter than a cherry red, as overheating destroys the good qualities of the steel.

FORGING—Steel forging is similar to iron forging. Heavy blows should be delivered so that the piece may be formed with as little heating as possible. Never hammer the steel after it loses its redness.

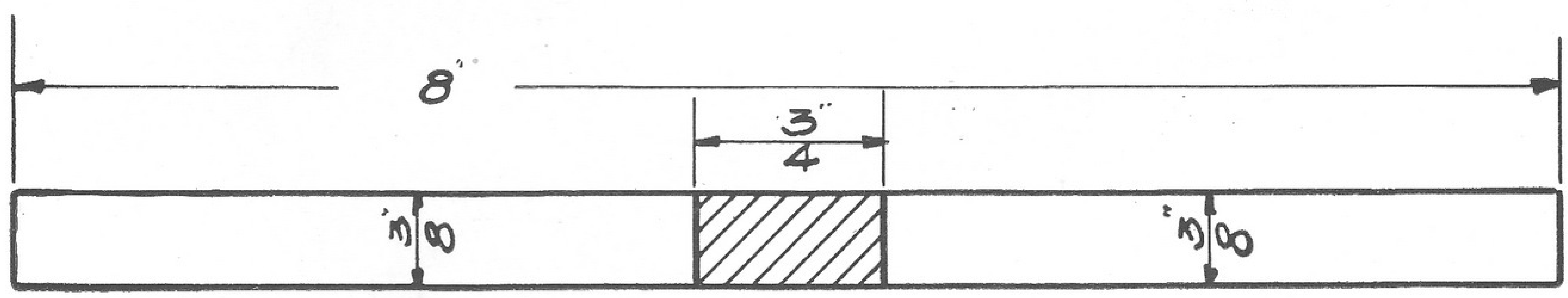


FIG-13-A

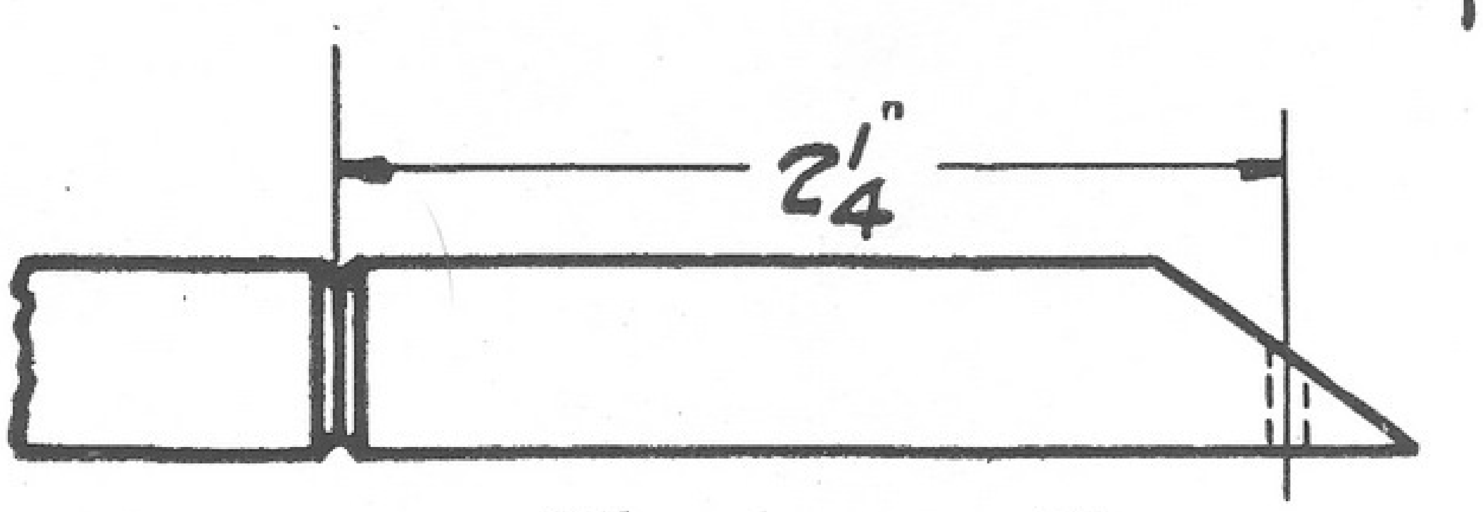


FIG-13-B

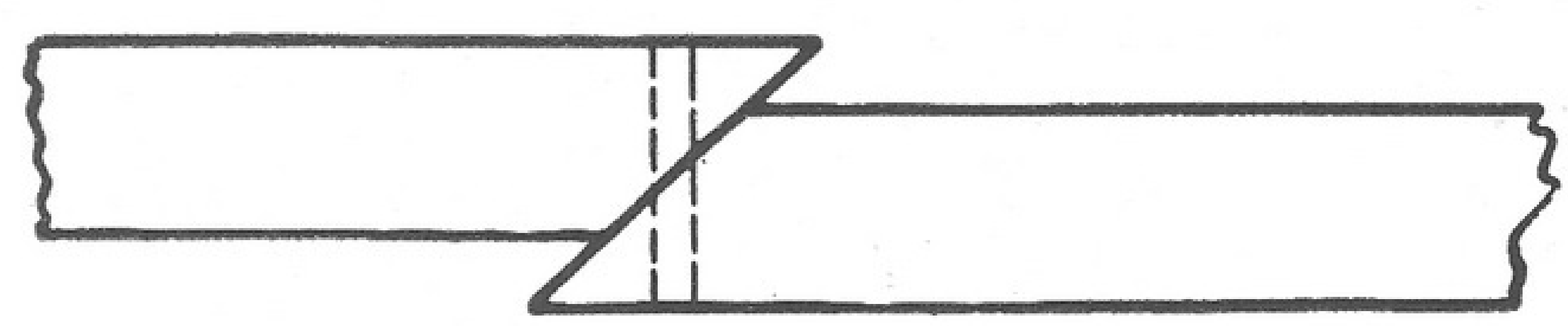
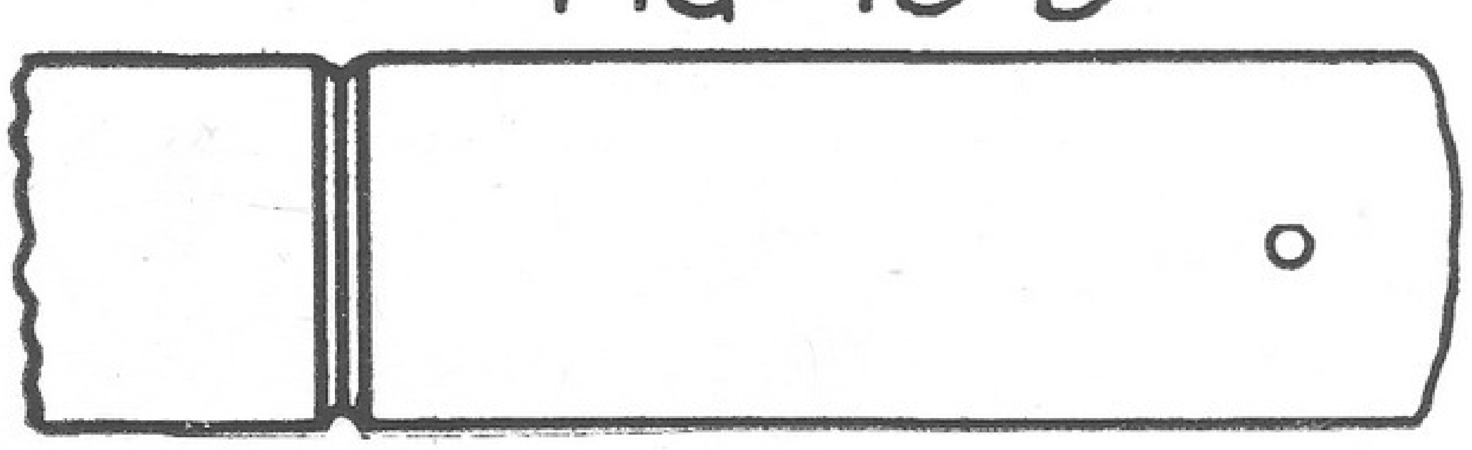
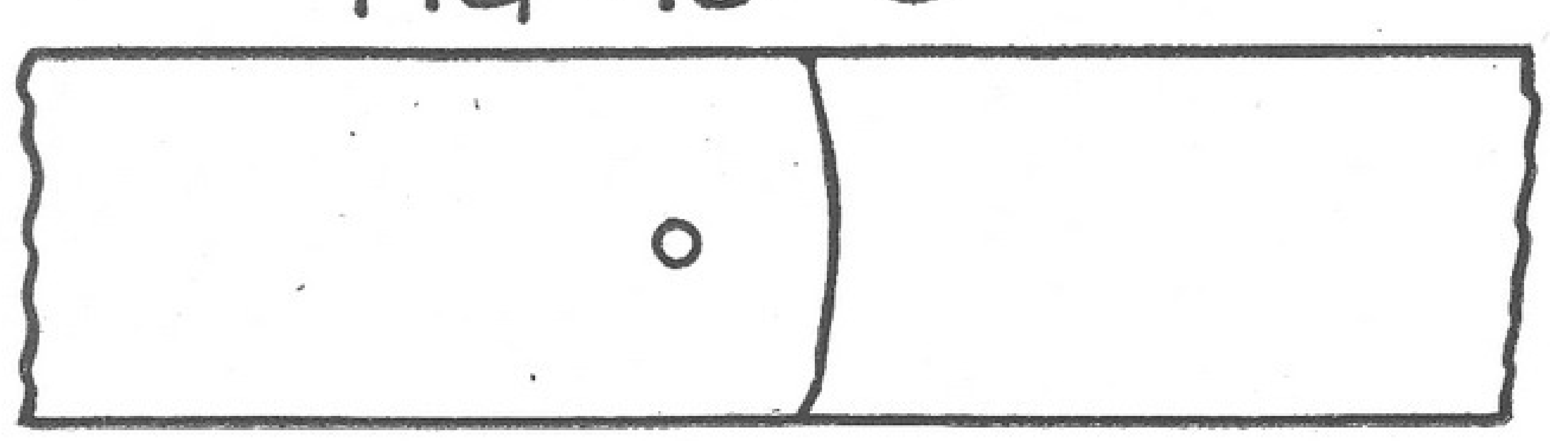


FIG-13-C





Exercise No. 14

Stock—Norway Iron—½" diameter. Finished Piece. From Exercise No. 4

EXPLANATION—The finished piece must agree with Fig. 14 A in form and dimensions.

OPERATION—Make center punch mark 1½" from round end, heat to a white heat, place the mark over the edge of the anvil, and bend as shown by Fig. 14 B. Deliver blows as indicated by Fig. 14 C, taking care that they fall in line with the stock, and that latter does not bend in any direction, as for example, in the direction *A* and *B*. When the stock is reduced to the proportions shown by Fig. 14 D, draw the scarf, Fig. 14 E.

Deliver one blow as indicated in Fig. 14 D, and then turn the stock and strike as shown by Fig. 14 F. Draw the eye to the proper thickness and make it round in plan, Fig. 14 G. By punching, the diameter of the eye will be increased by nearly an ⅛" so that at this stage its diameter should be ⅞".

In punching the hole work from one side until a dark spot appears on the other side under the punch, then turn the work over, and guided by the dark spot, start the punch in the opposite direction. When the punch is well started, bring the stock over a hole in the anvil so as to allow the little button that is formed to drop out. The punched hole will agree with the taper of the punch; to make its diameter uniform drive a drift-pin, Fig. 14 H, entirely through. The drifted hole will correspond to the largest diameter of the drift-pin.

CAUTION—If the scarfing is not properly done, the stock will be cut where the eye joins the body. Do not keep the punch too long in the work—strike two or three sharp blows then dip the punch in water.

If the punch becomes hot it will upset in the stock so that it cannot be easily withdrawn.

FIG-14-A

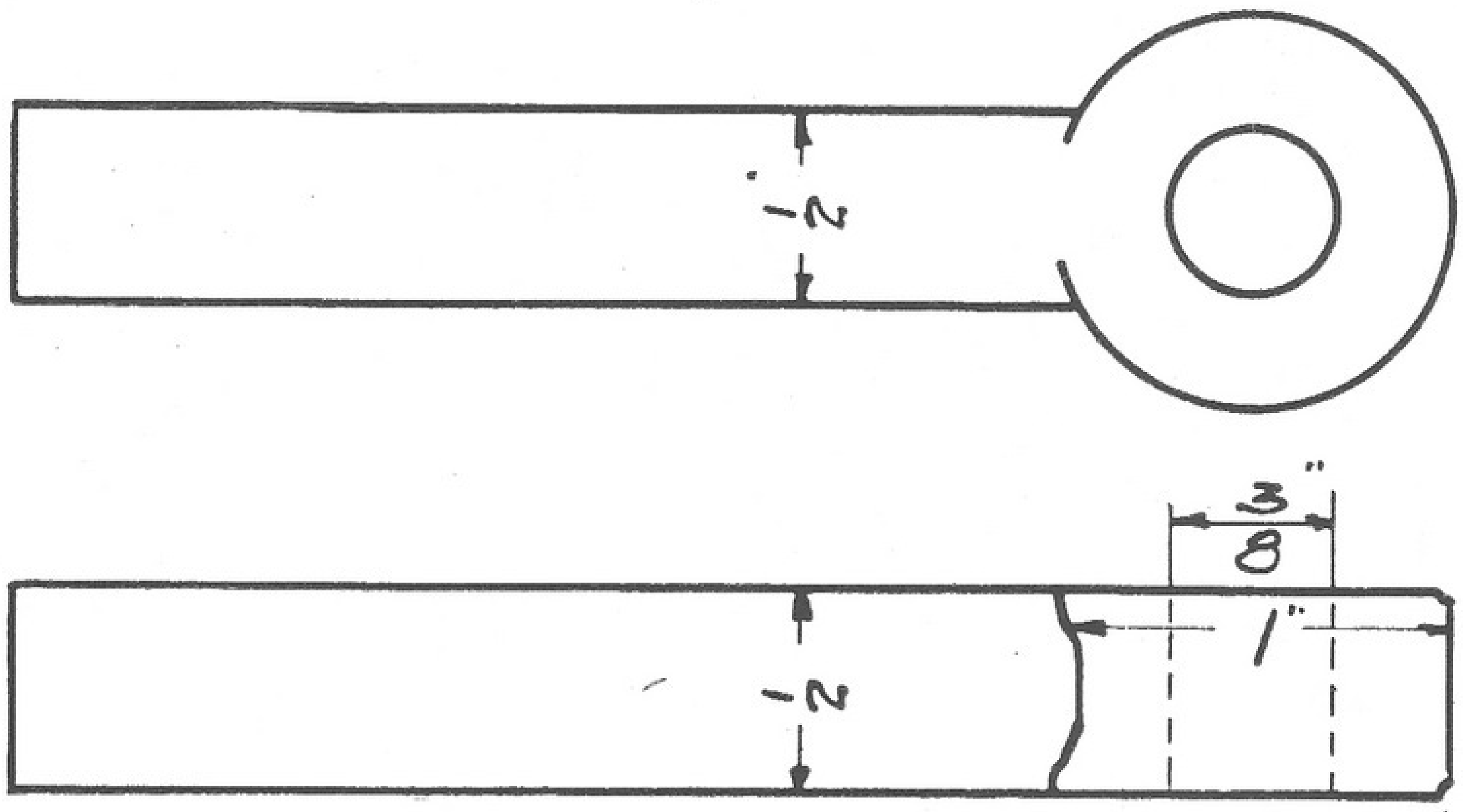


FIG 14 B

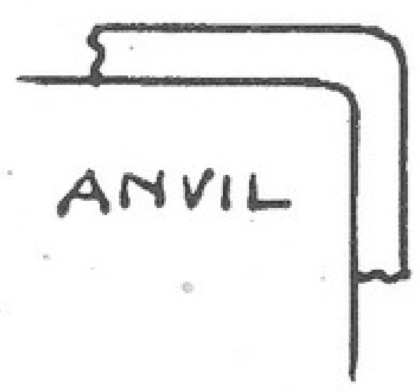


FIG 14 D

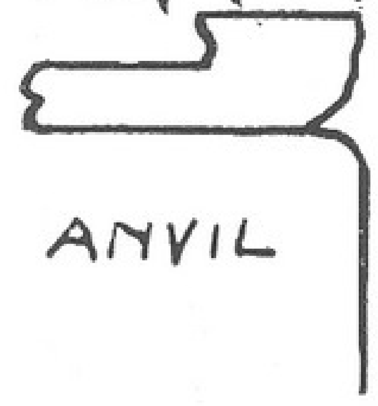


FIG 14 C

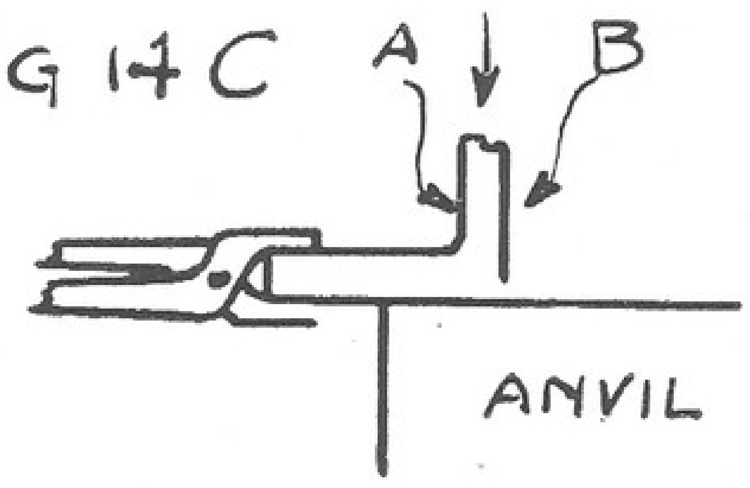


FIG-14-E

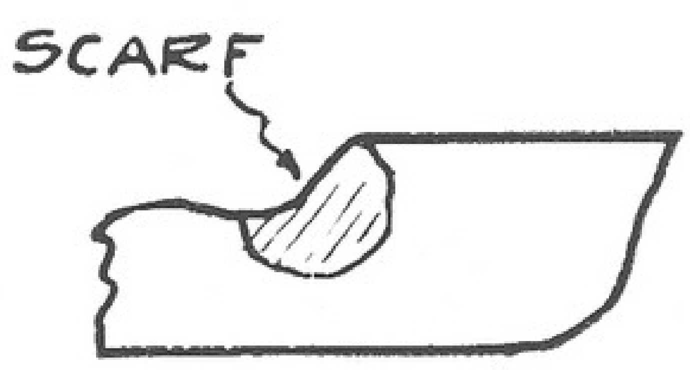


FIG 14-F

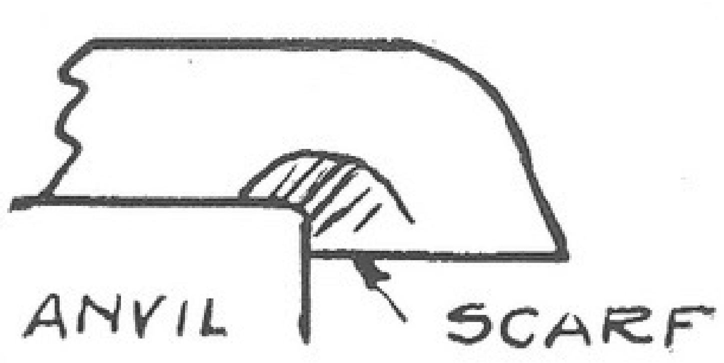


FIG 14 G

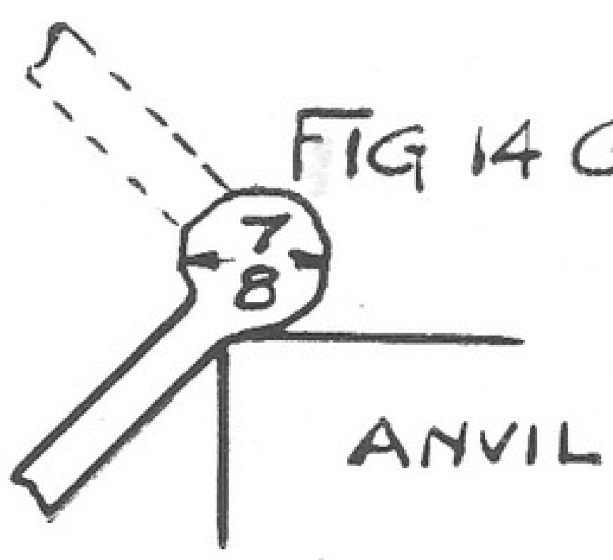
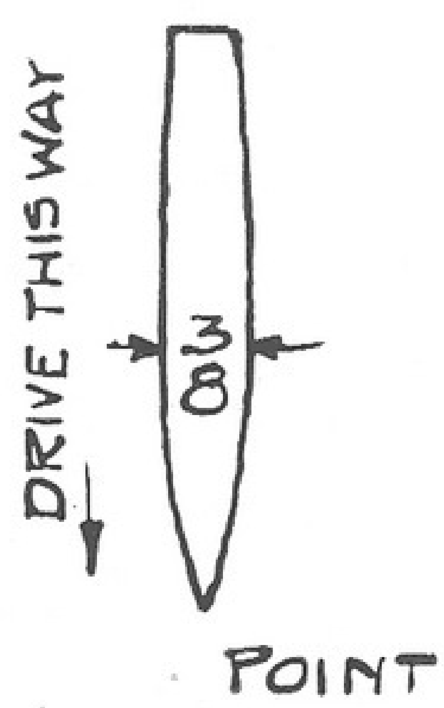


FIG 14 H
A DRIFT



Exercise No. 15

Stock—Norway Iron—3/8″ x 3/8″—Convenient length

EXPLANATION—This exercise in nail-making affords excellent practice in the use of the heading tool. Five nails are to be made, each as nearly as possible of the form shown by Fig. 15 A.

OPERATION—Draw the stock to the form shown by Fig. 15 B and try it in the heading tool to make sure that it will enter to the shoulder, leaving sufficient material above the shoulder to form the head, cut all around as shown by Fig. 15 C. Heat between the shoulder and cut, thrust the stock into the heading tool, and by a forward and backward movement, break it off at the cut. Deliver blows as shown by Fig. 15 D to make the head.

If it is found that the head is forming on one side of the body, Fig. 15 F, draw in the proper direction by blows as indicated by arrow.

By a little practice one can make a nail at a single heat.

CAUTION—Do not allow the nail to become injured by the conditions illustrated by Fig. 15 F.

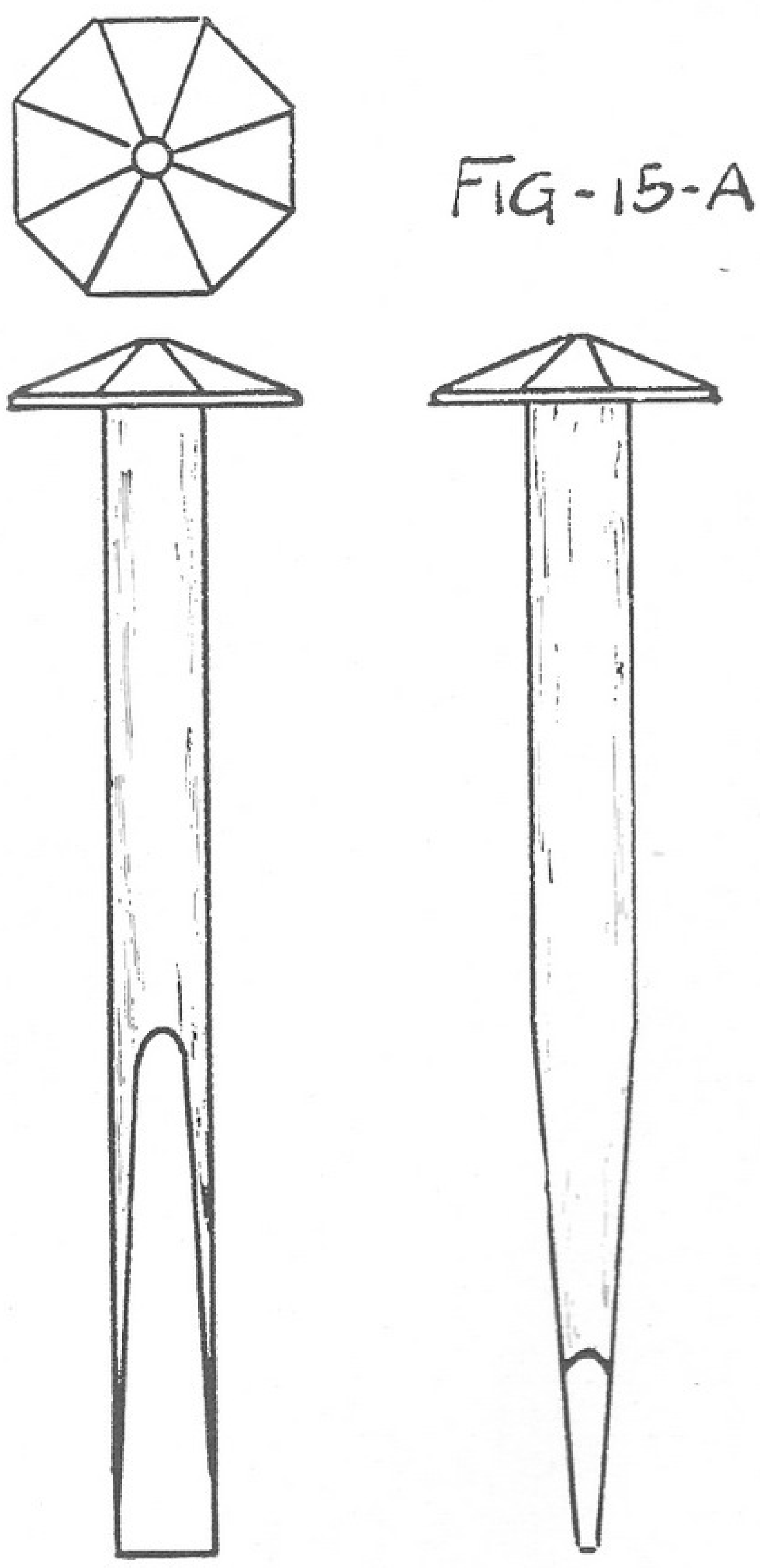


FIG-15-A

FIG 15-B

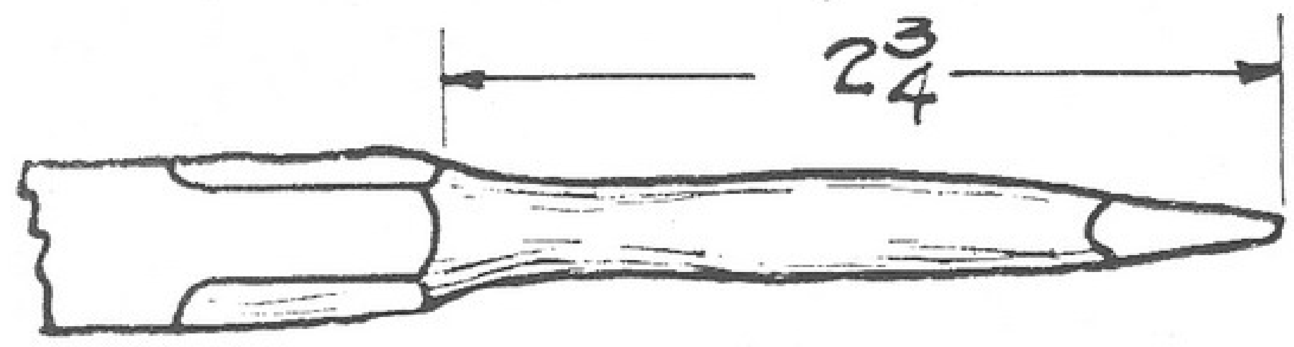


FIG-15-C

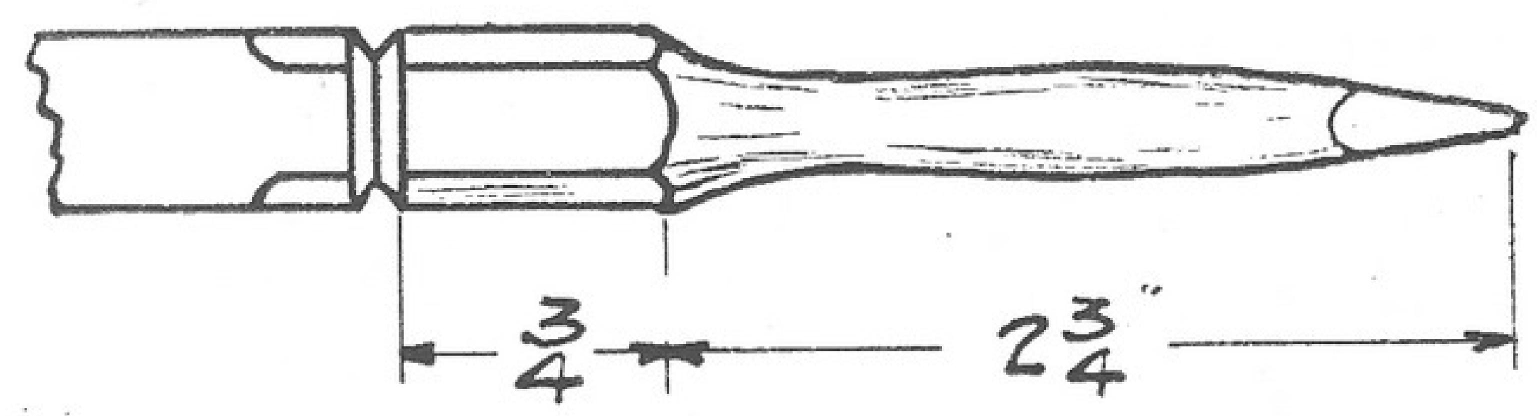


FIG 15 D

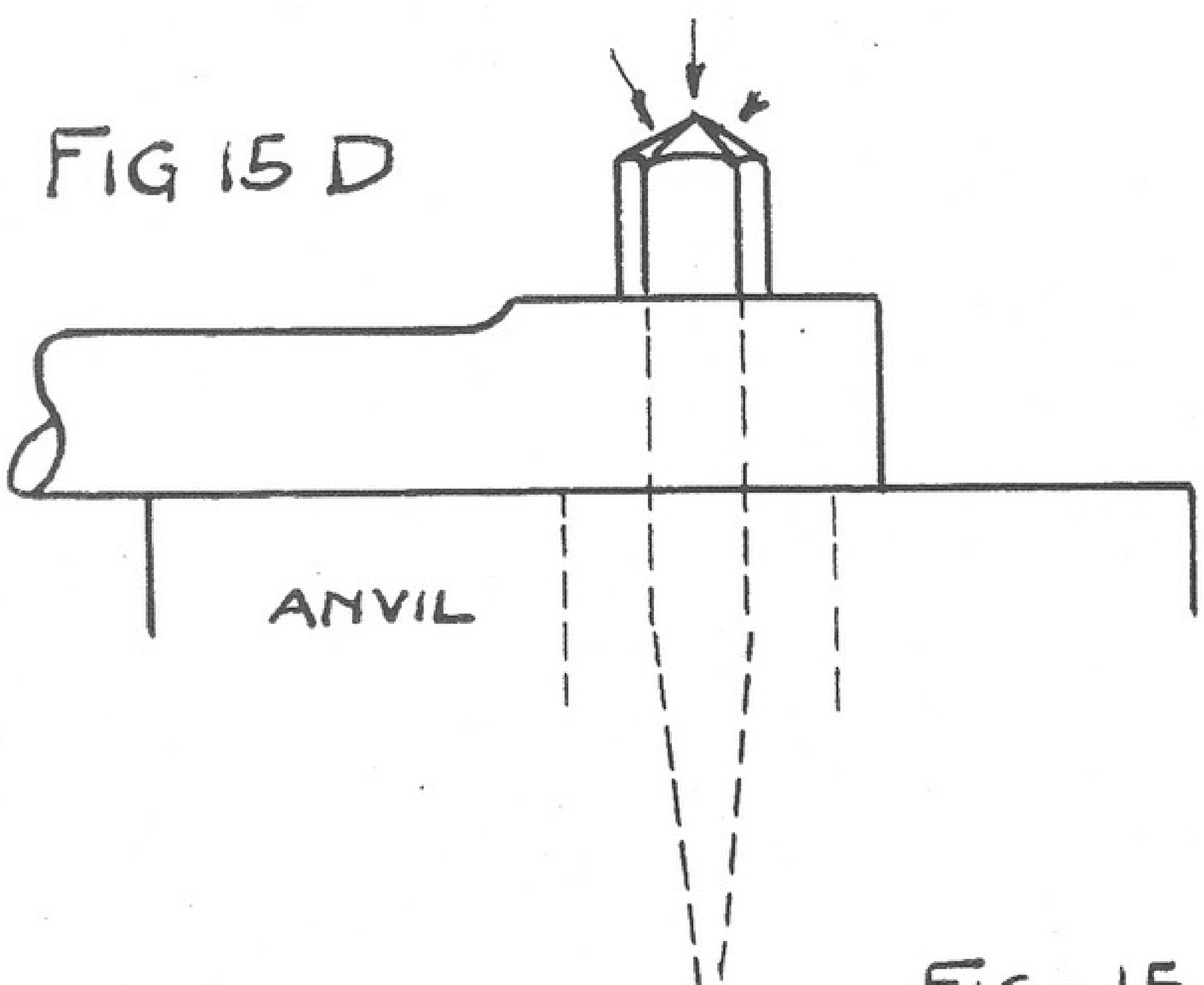


FIG 15-F

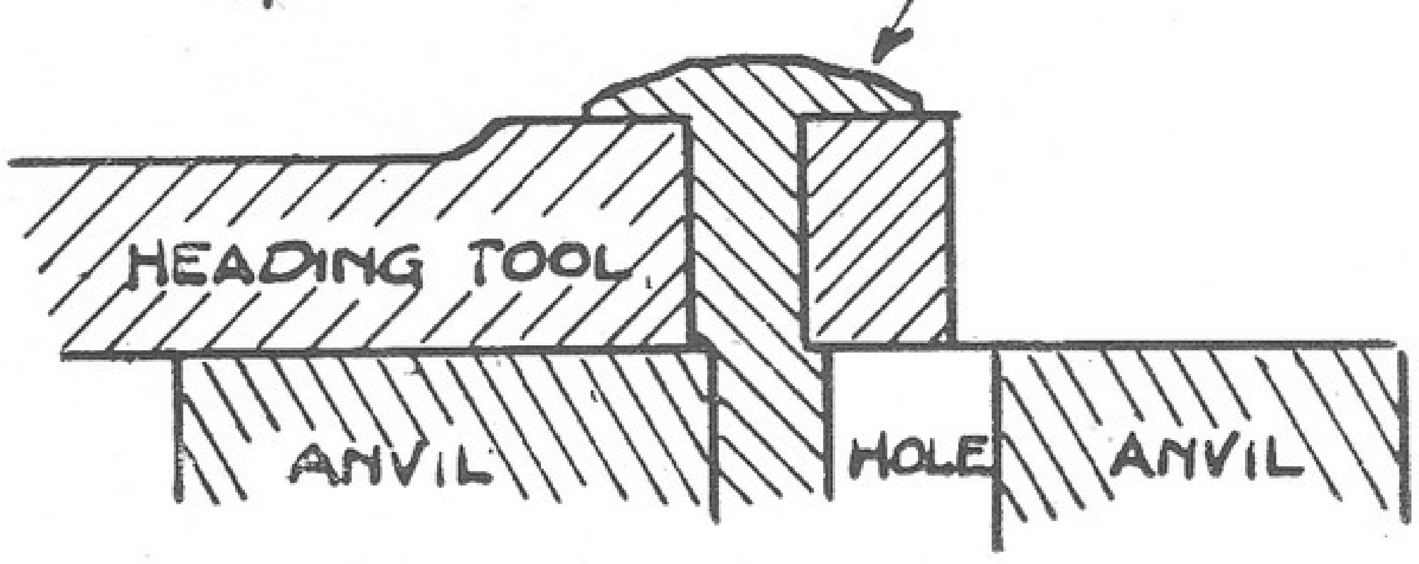
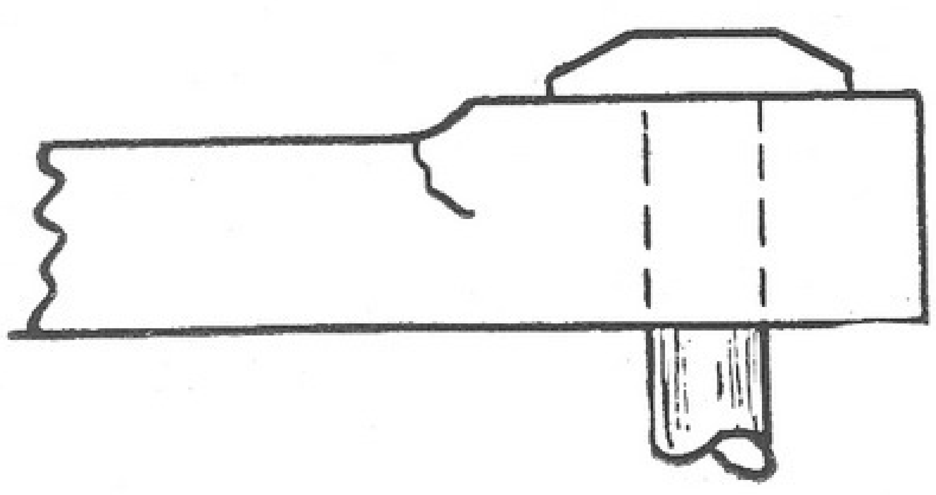


FIG.- 15 E



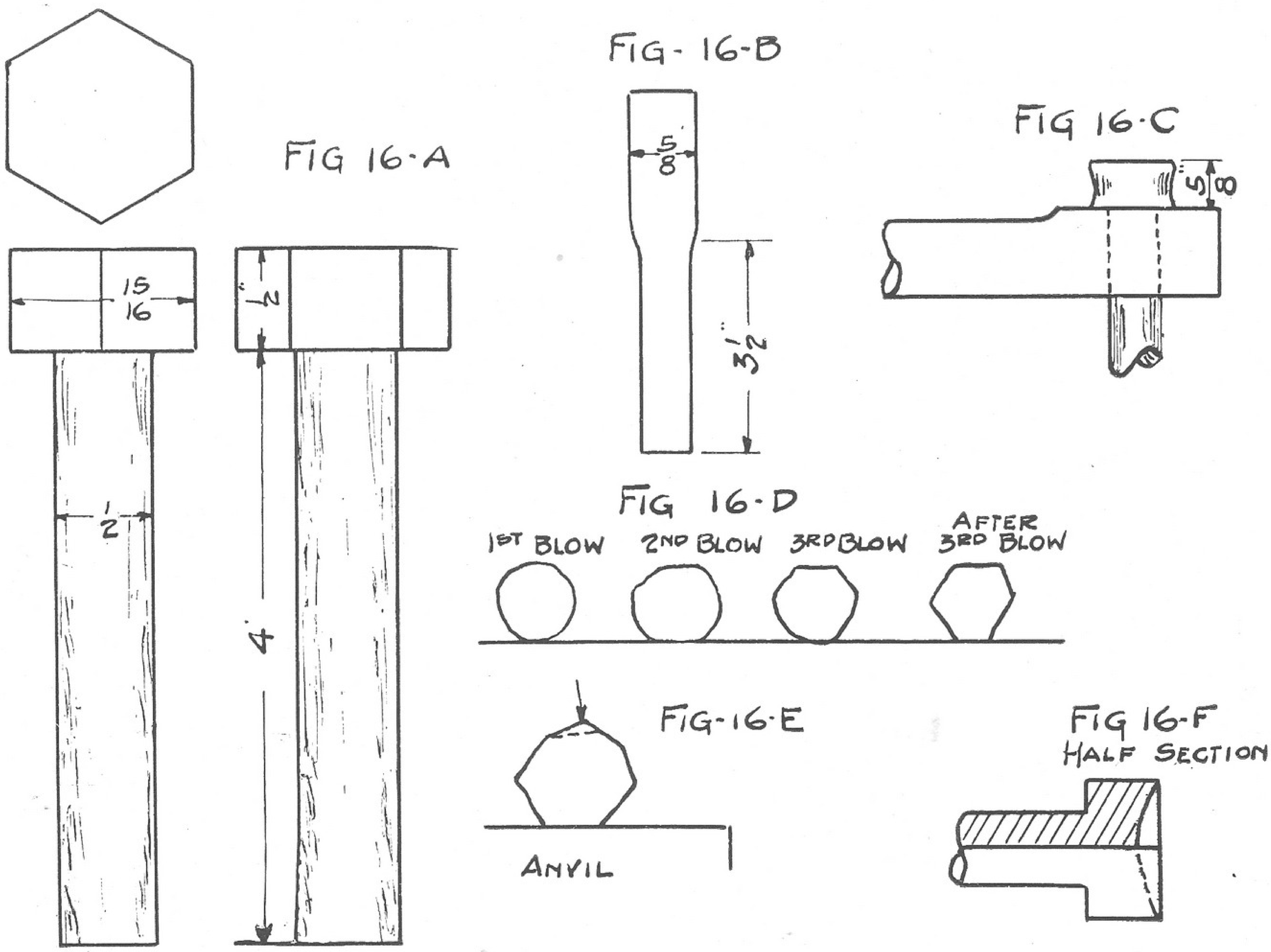
Exercise No. 16

Stock—Norway Iron—½″—diameter, 6¼″ long

EXPLANATION—The finished piece is shown by Fig. 16 A. The body must be straight and concentric with the head. If the proper amount of stock is not secured in the head, its diameter should be maintained at the expense of its thickness.

OPERATION—Upset as shown by Fig. 16 B. If the end *A*, Fig. 16 B, becomes battered or upset, it must be drawn to its original diameter. Forge to the form shown by Fig. 16 C, taking care that the upset portion is in the center of the stock. See Fig. 16 E. Take the stock from the heading tool and strike three blows as indicated by Fig. 16 D. If the surfaces thus produced are an equal distance apart continue to draw them without regard to the diameter of the head, until the proportion of the head in plan is satisfactory. If it is found that some of the faces are becoming wider than others, draw as shown by Fig. 16 E. After getting the form in plan, use the heading tool again to bring the head to thickness. So continue until the head is finished.

CAUTION—Be careful that in using the heading tool the first time, Fig. 16 C, the stock is not made too thin. The center of the head cannot be thickened: the most that can be done if it is once made too thin is represented by Fig. 16 F.



Exercise No. 17

Stock—Norway Iron—1″ x ½″—Convenient length

SQUARE NUT—Finished to dimensions and form of Fig. 17 A, process shown by figures.

FIG-17-A

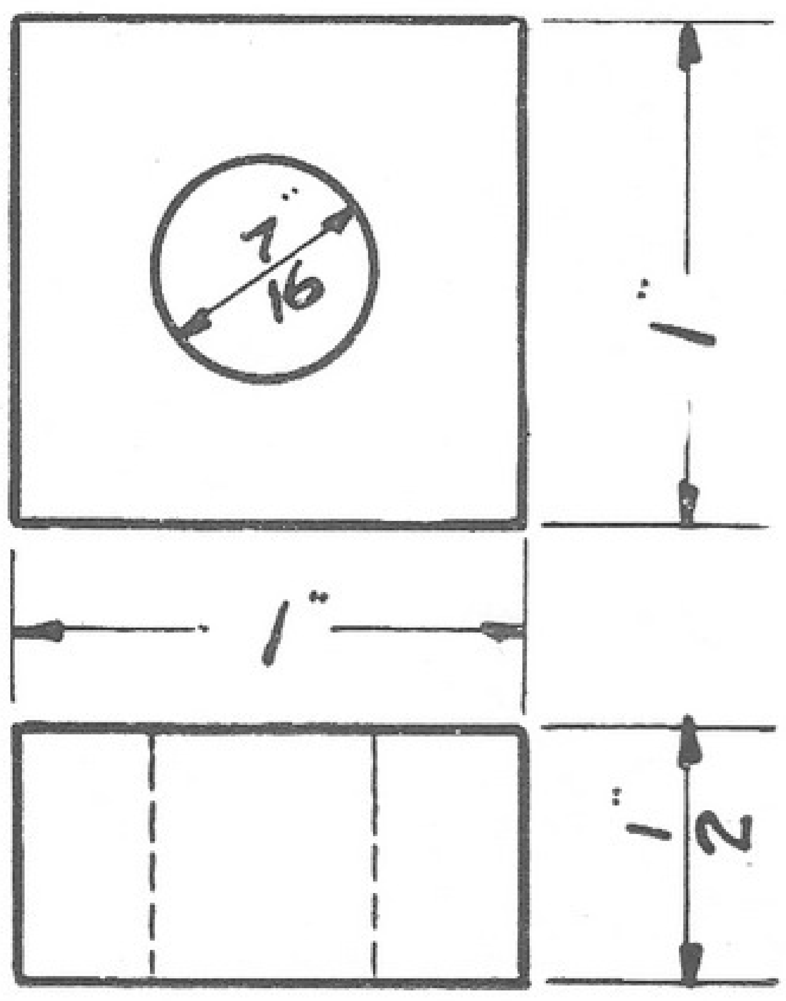


FIG-17-B

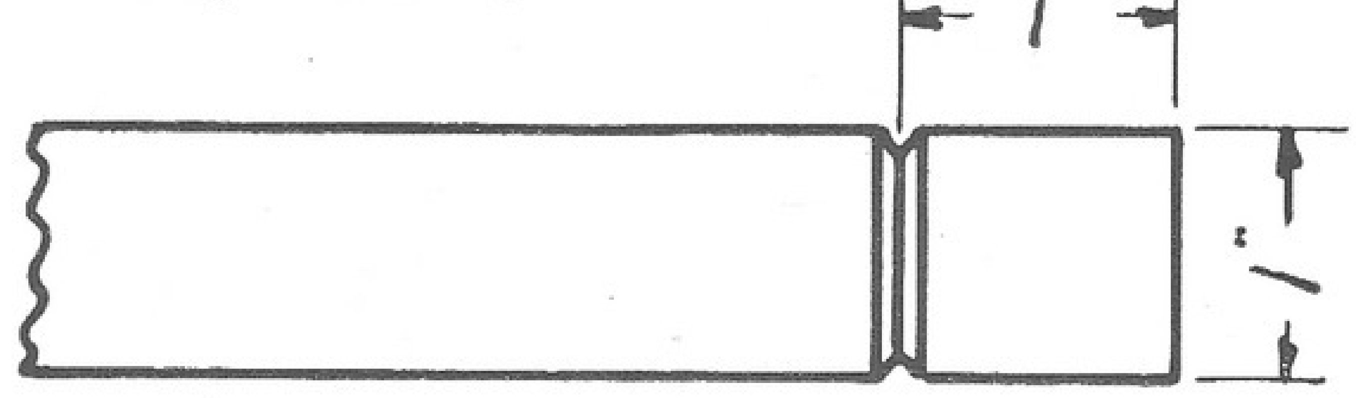
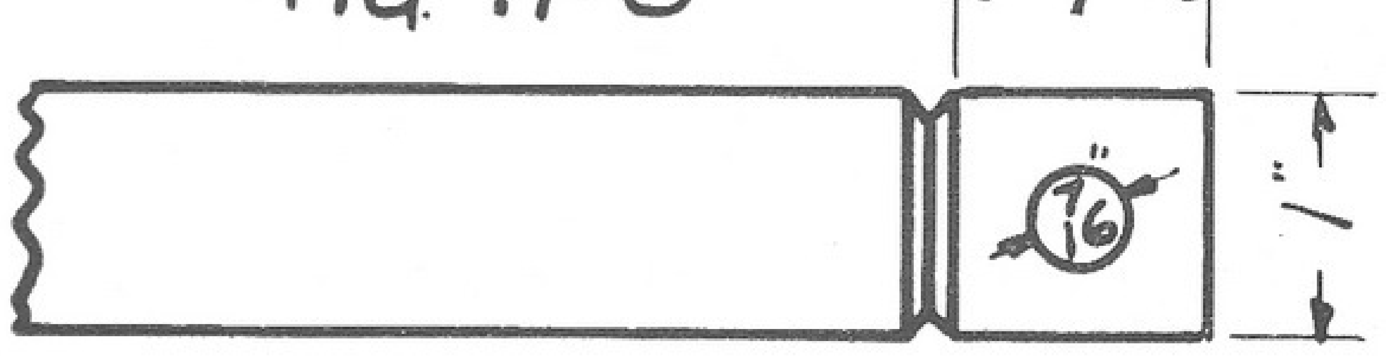


FIG.-17-C



Stock—Norway Iron—1″ x ⅜″—Convenient length

HEXAGON NUT—Finished to form and dimensions of Fig. 17 D, process shown by figures.

FIG.-17-D

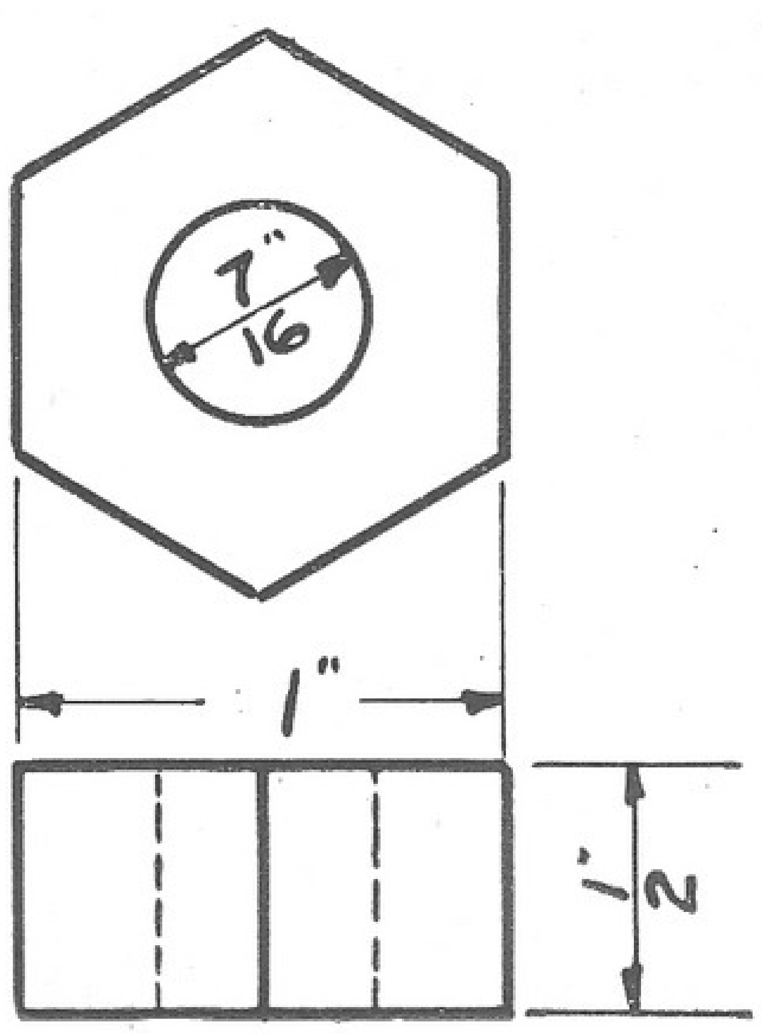


FIG. 17-E

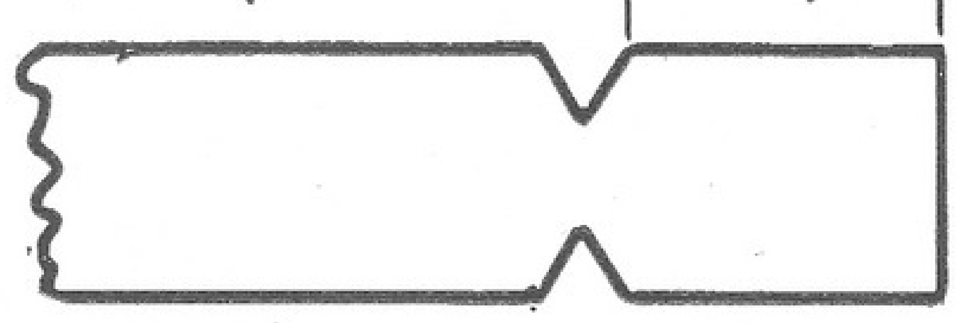


FIG-17 G

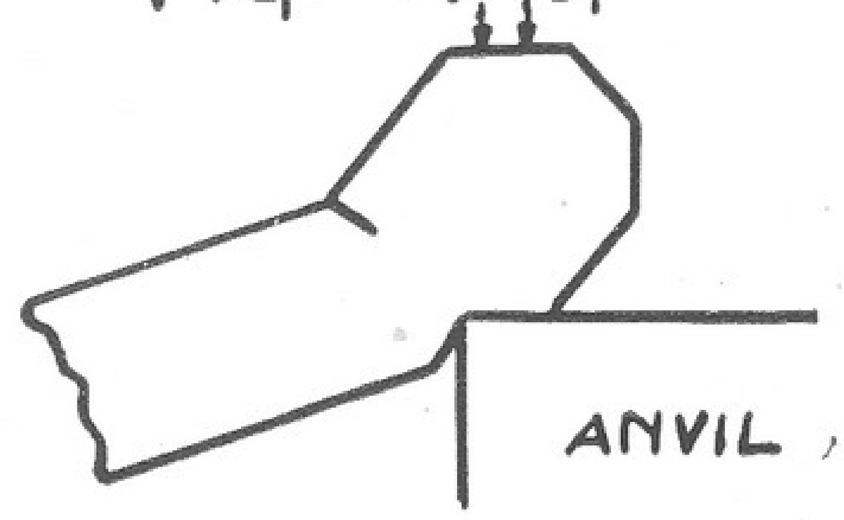


FIG-17-F

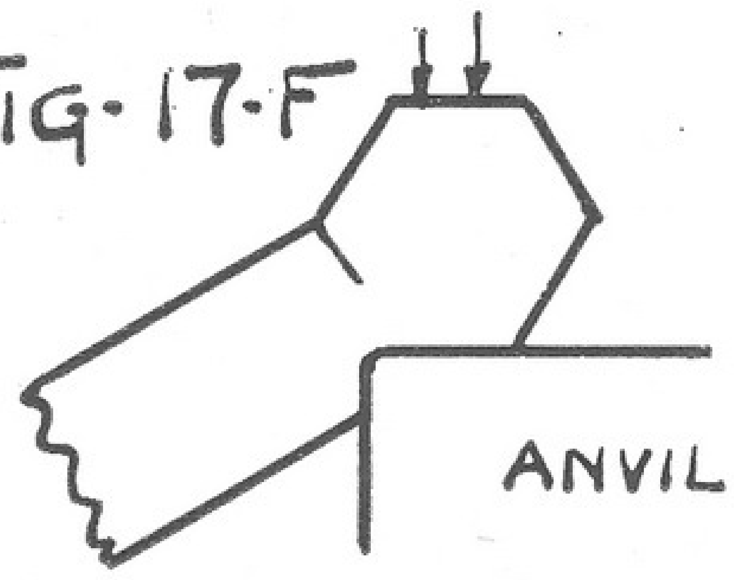
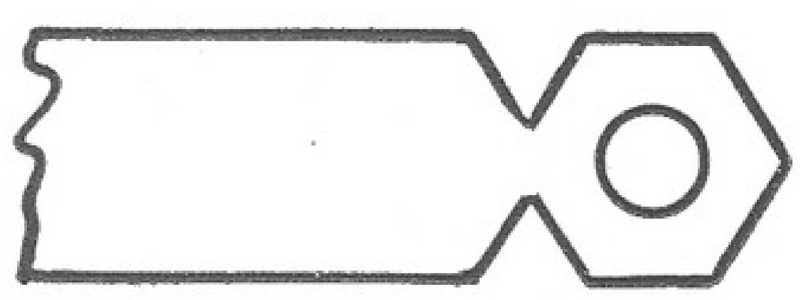


FIG 17-H



Exercise No. 18

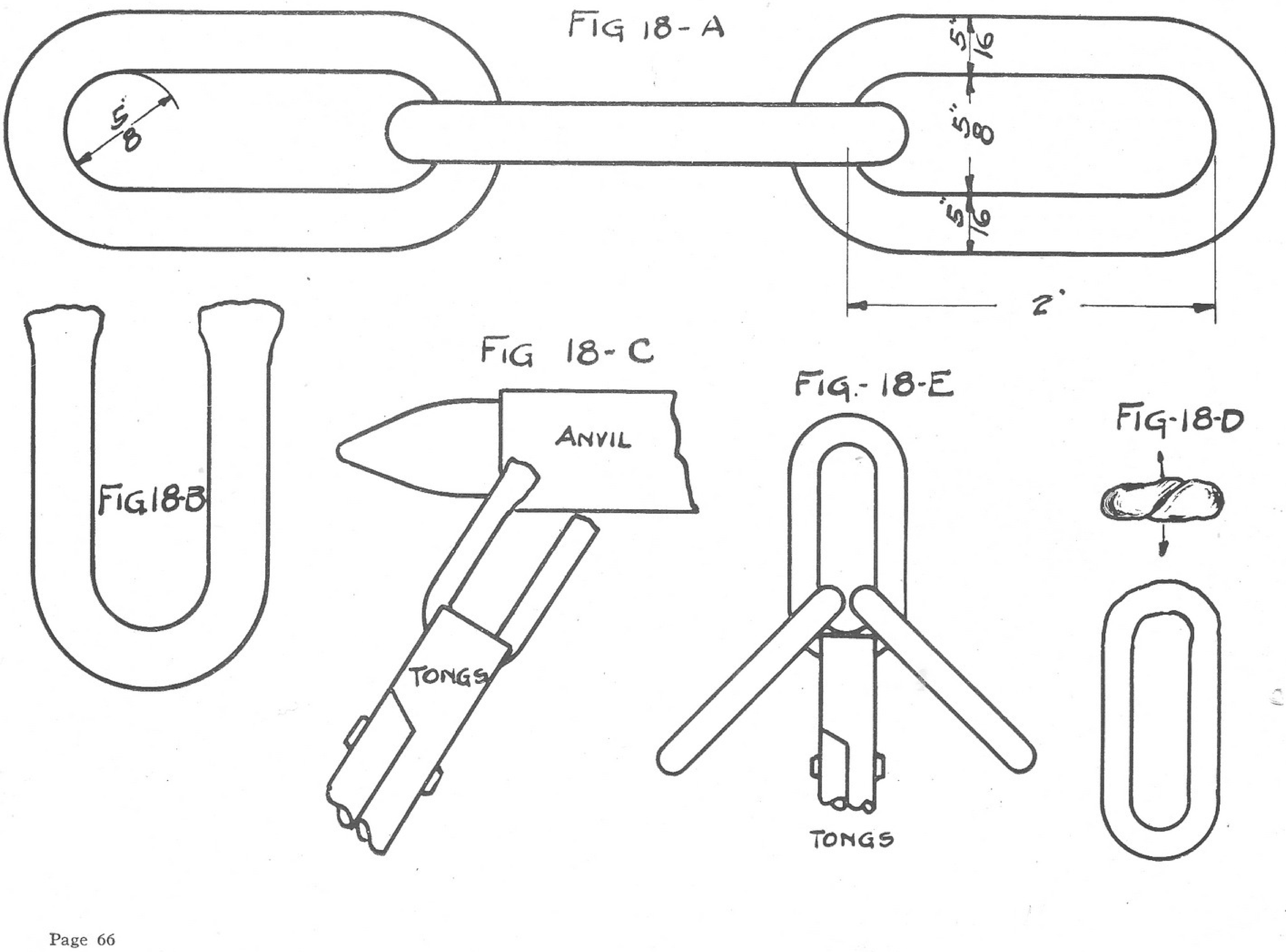
Stock—Norway Iron—3 Pieces—$\frac{5}{16}''$ diameter—6″ long

Three links of a chain, shown in Fig. 18 A, form the finished piece.

OPERATION—Upset each end of the piece, taking one heat for each end. Heat the piece in the center, cool about 1½″ of each end and bend to the shape of the letter U, Fig. 18 B.

In scarfing the ends, place one end upon the sharp edge of the Anvil, Fig. 18 C, and striking light blows, swing the piece around bringing the toe of the scarf to a thin edge. After one end is scarfed turn the piece over and scarf the other in the same manner. Bend the scarfed ends over the horn of the anvil so they will lap as shown by Fig. 18 D.

Weld and finish two links each independent of the other and complete in itself. Bring third link to the form of Fig. 18 D. Spread the ends in the direction shown by arrows and slip on the finished links. Apply the tongs as shown in Fig. 18 E, close the ends of the link, and weld. In finishing see that the links are of the same size and form.



Exercise No. 19

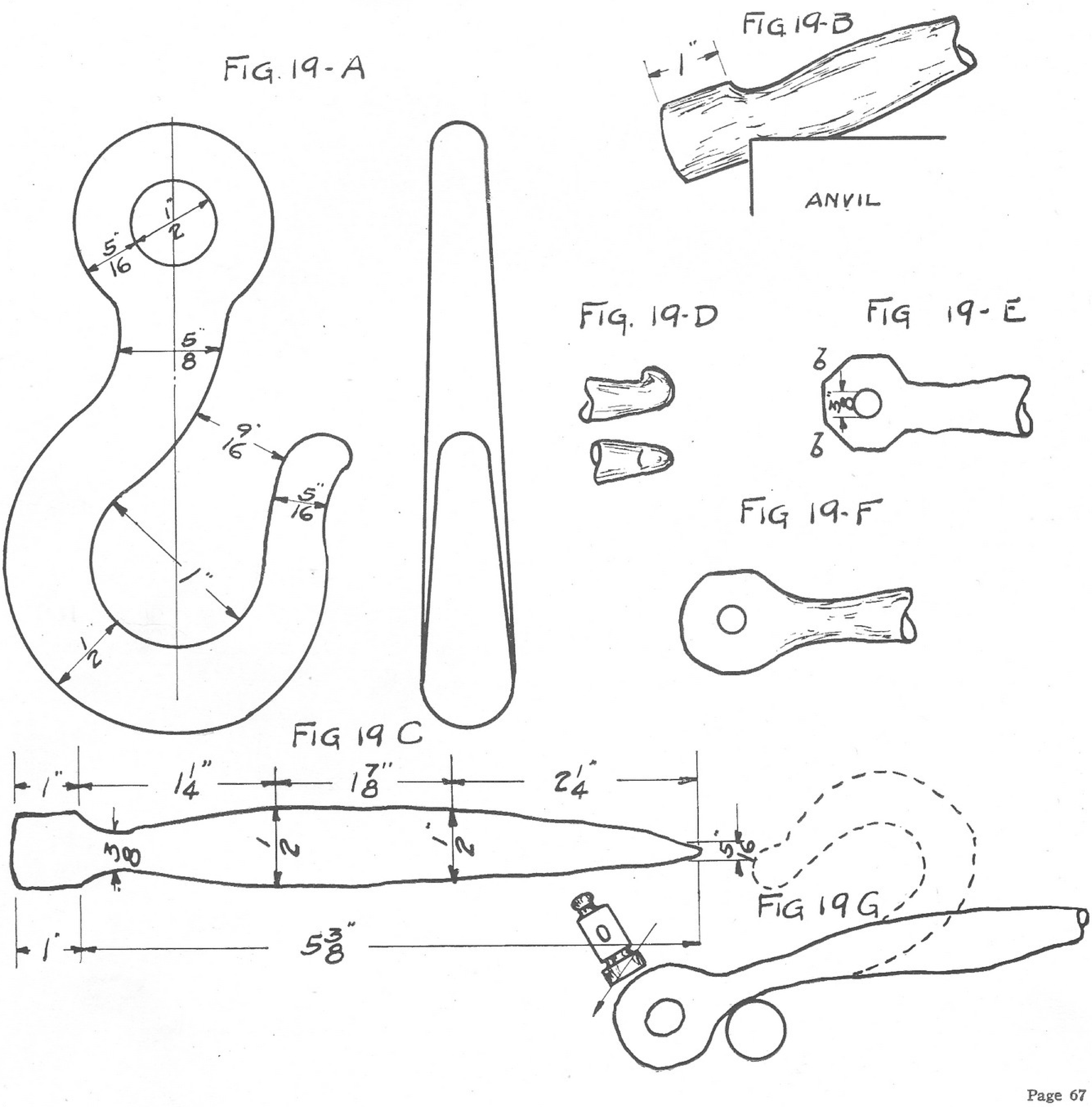
Stock—Norway Iron—⅜″ x 1″—4½″ long

The hook as shown by Fig. 19 A is the finished piece.

OPERATION—Lay off center punch mark 1″ from one end. Heat and draw first to the form shown by Fig. 19 B, then to that shown by Fig. 19 C. Set over the end, Fig. 19 C, and finish as shown by Fig. 19 D.

Cut the corners, punch the hole, Fig. 19 E and draw the eye on the horn to the form shown by Fig. 19 E.

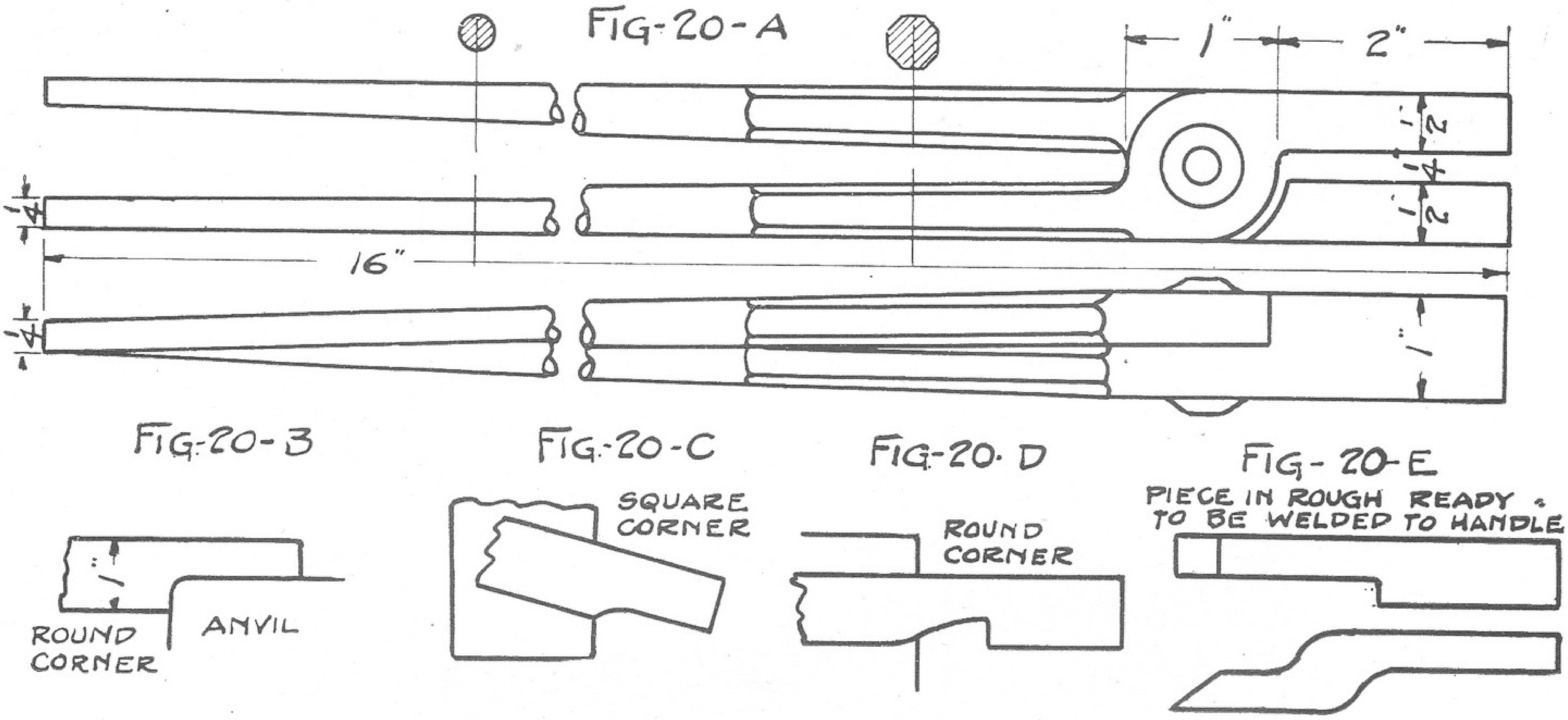
Heat at O, Fig. 19 F, cool the eye and bend as shown by Fig. 19 G. Complete the bending as indicated by the dotted lines, Fig. 19 G.



Exercise No. 20

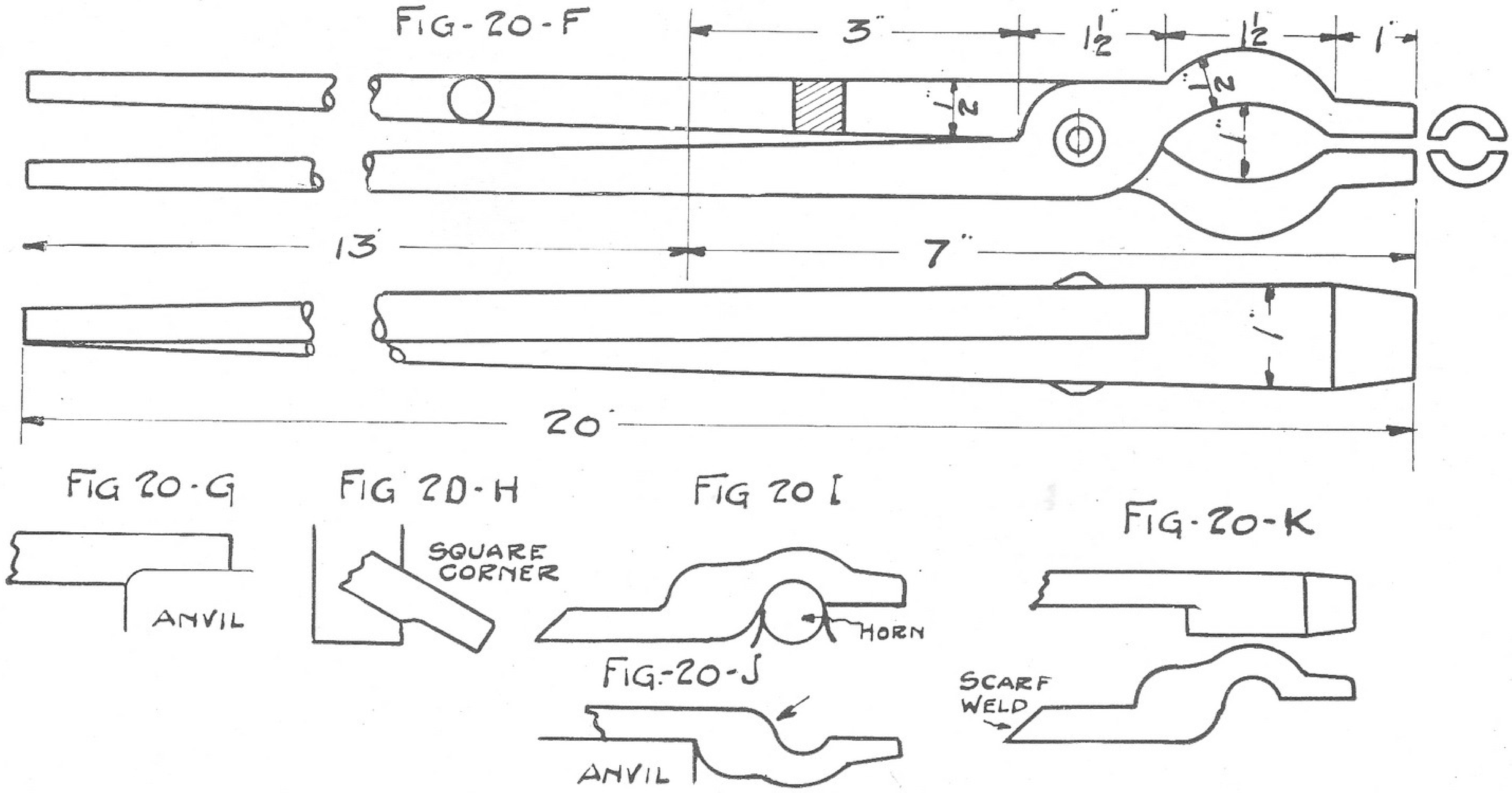
Stock—Norway Iron—1″ x 1″—8″
½″ x ½″ x 8″—2 pieces

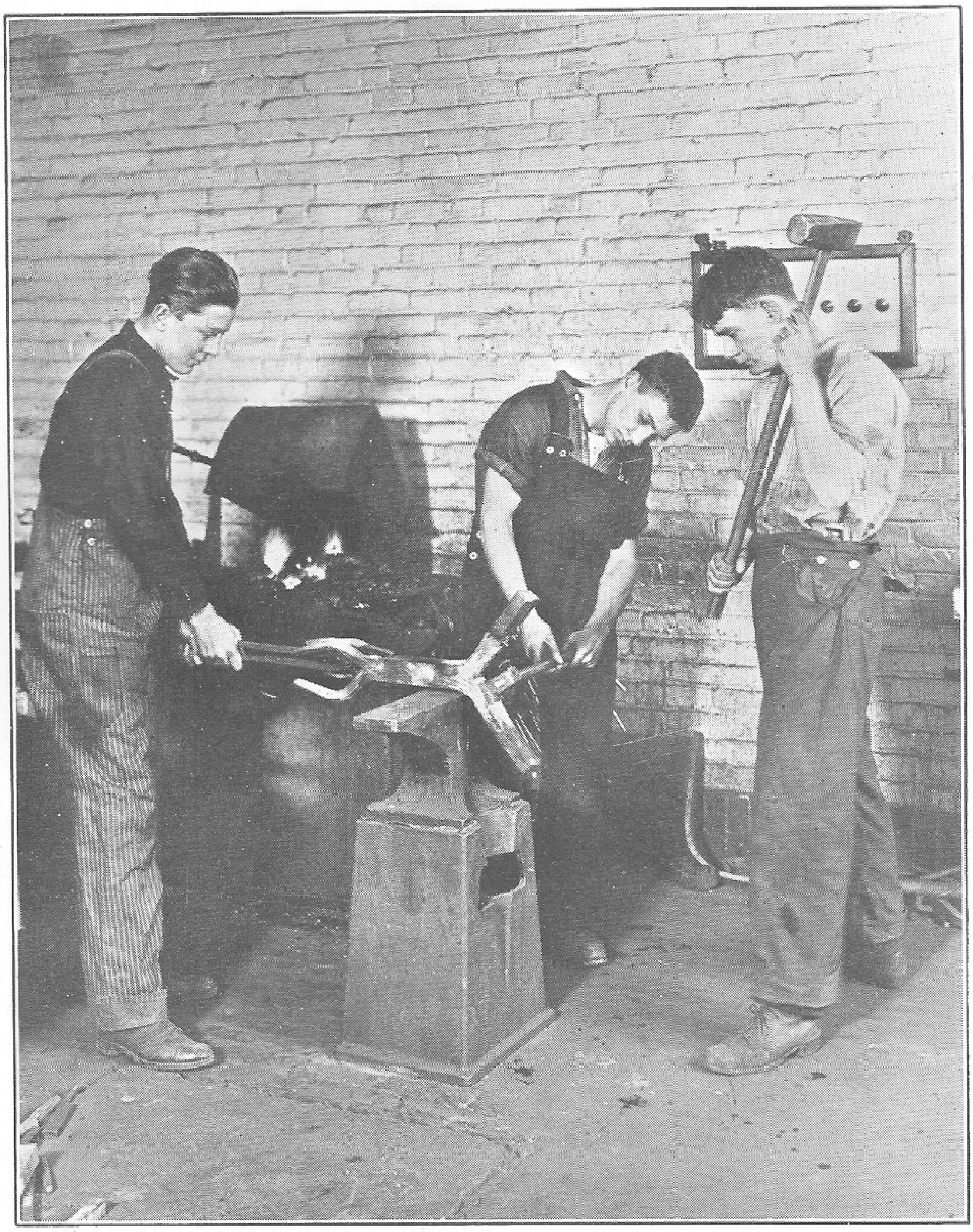
TONGS—Finished to size and form of Fig. 20 A. Process shown by figures; the two pieces are made alike and joined by a ⅜″ rivet. Fig. 20 A, shows position of weld in finished piece.



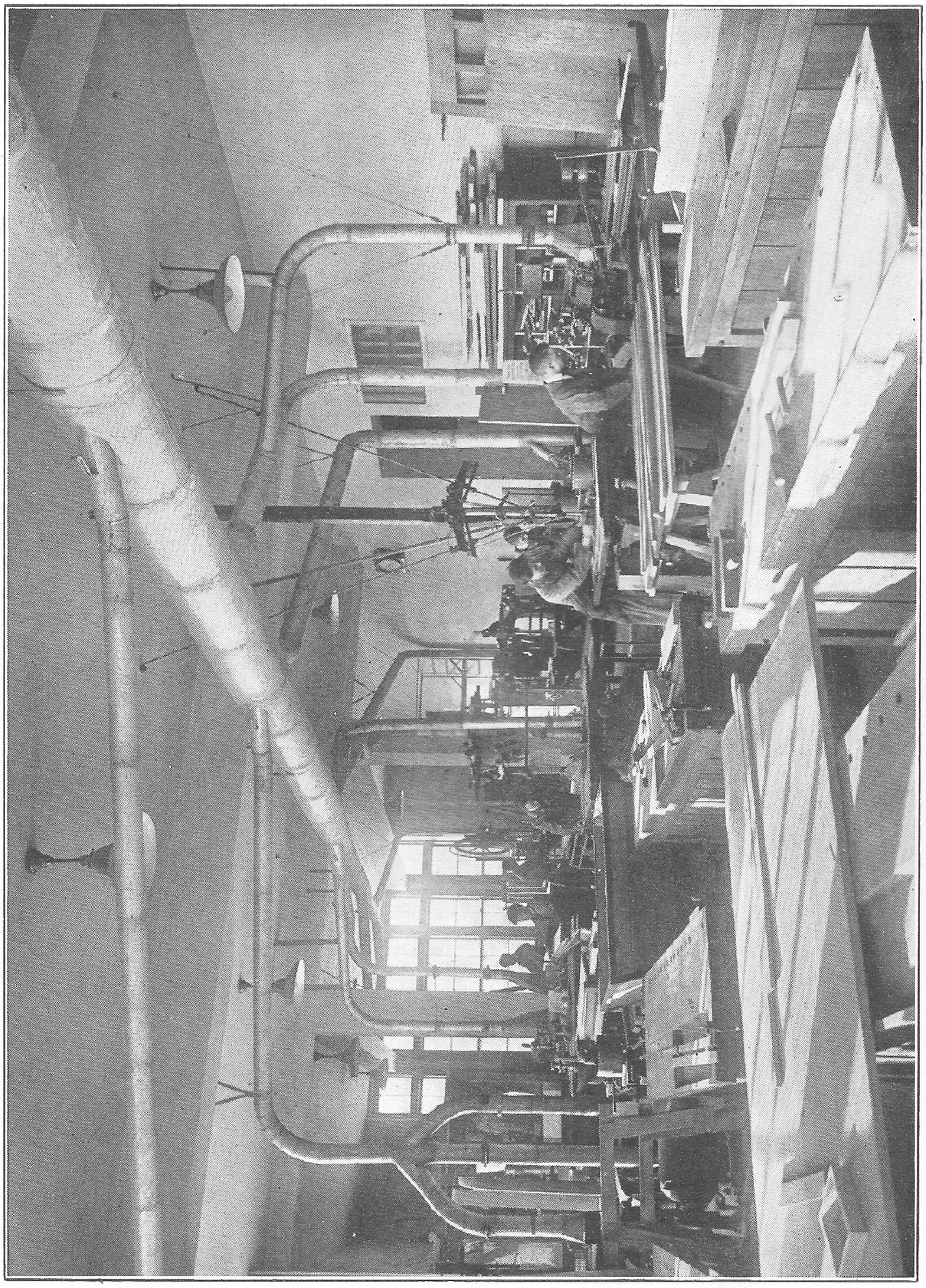
Stock—Norway Iron—1″ x 1″—8″—½″ diameter, 13″—2 pieces

TONGS—Finished to size and form of Fig. 20 F. Process shown by figures; the two pieces are made alike and joined by a ⅜″ rivet.

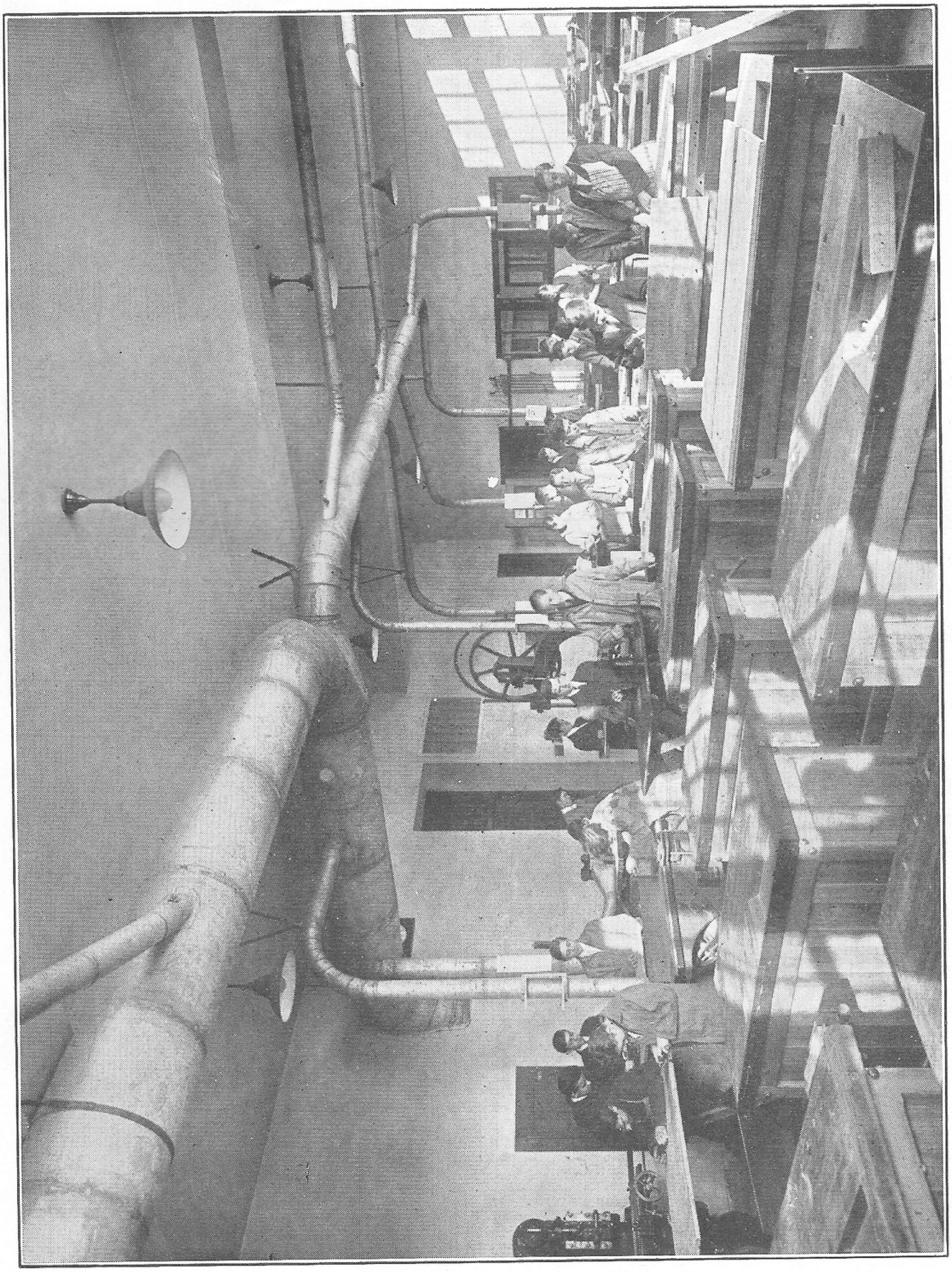




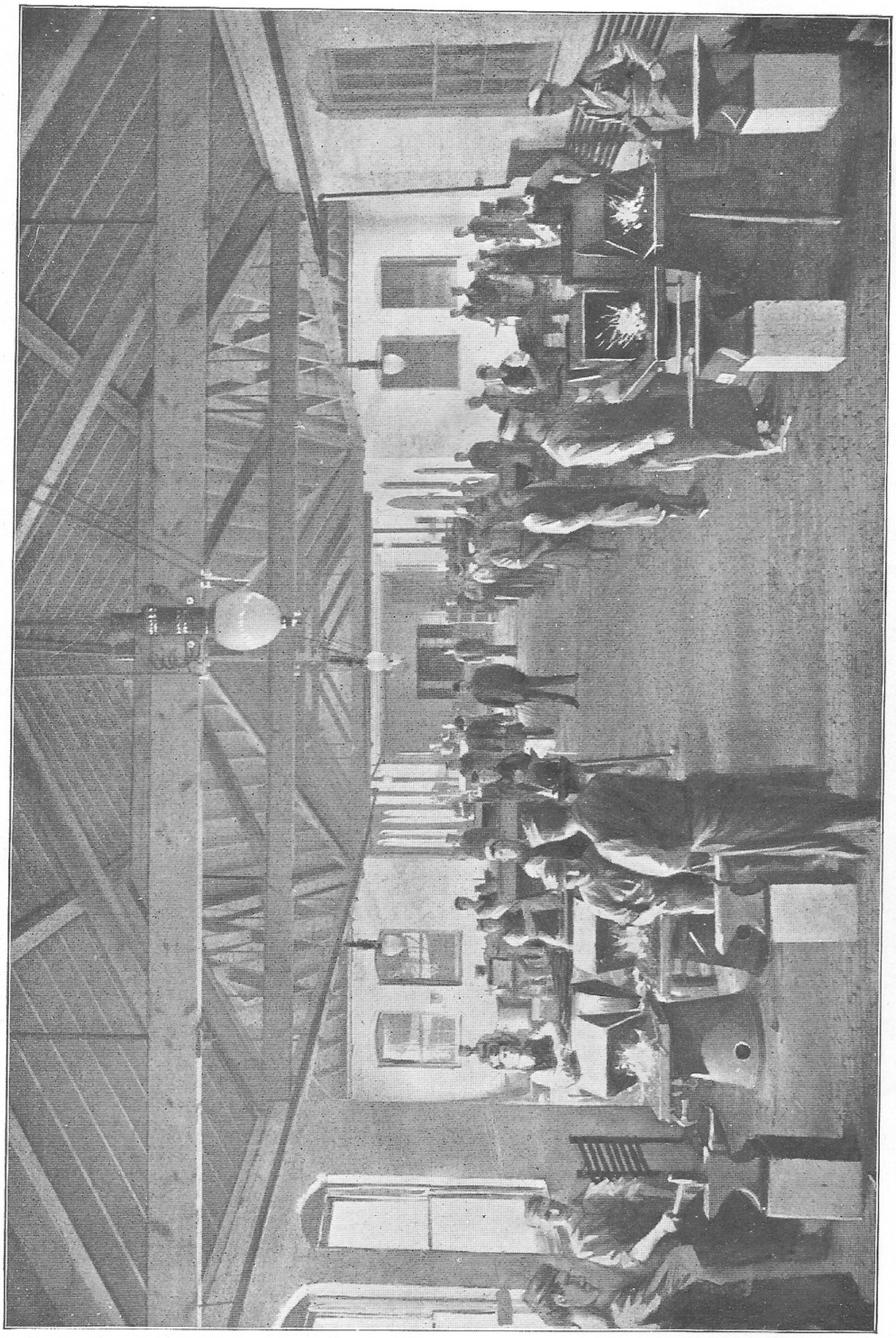
FORGE PRACTICE AT WENTWORTH INSTITUTE, BOSTON



AN EXHAUST SYSTEM KEEPS THE AIR FREE FROM DUST AND REMOVES SHAVINGS
TECHNICAL HIGH SCHOOL, BUFFALO, N. Y.

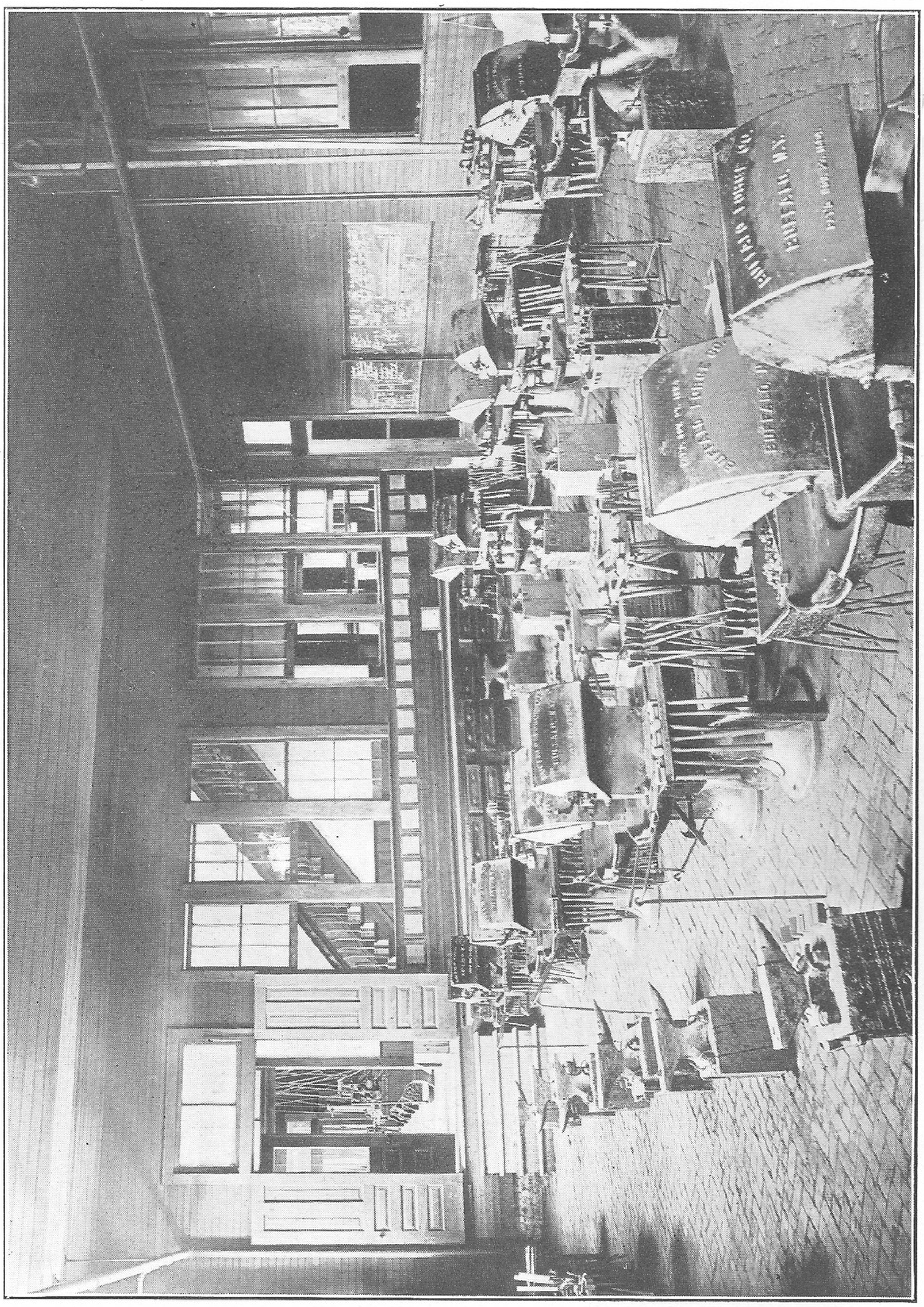


THE WOODWORKING DEPARTMENT IN TECHNICAL HIGH SCHOOL, BUFFALO, N. Y.

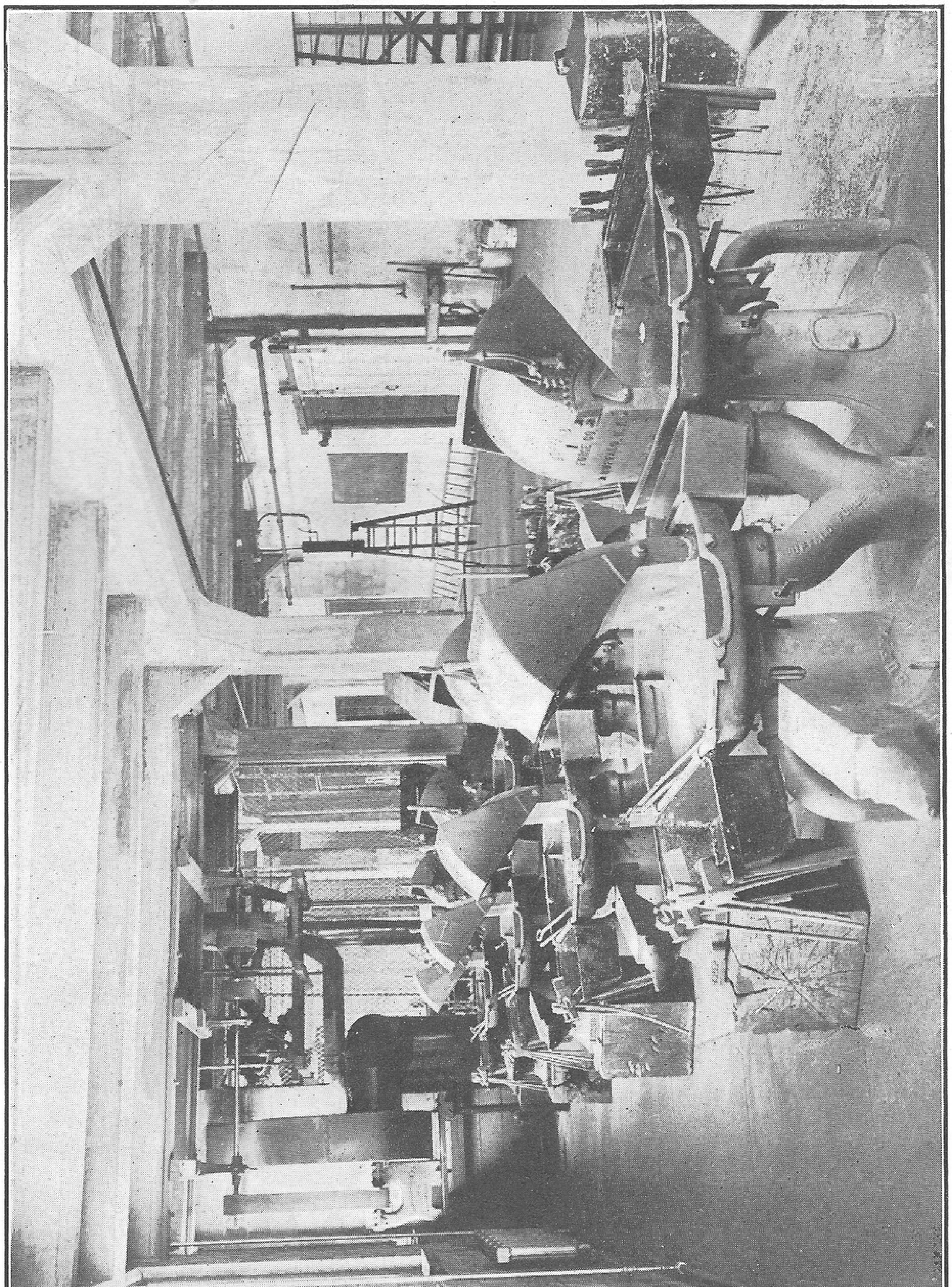


NEW YORK STATE REFORMATORY, ELMIRA, N. Y.—FORGE SHOP INTERIOR

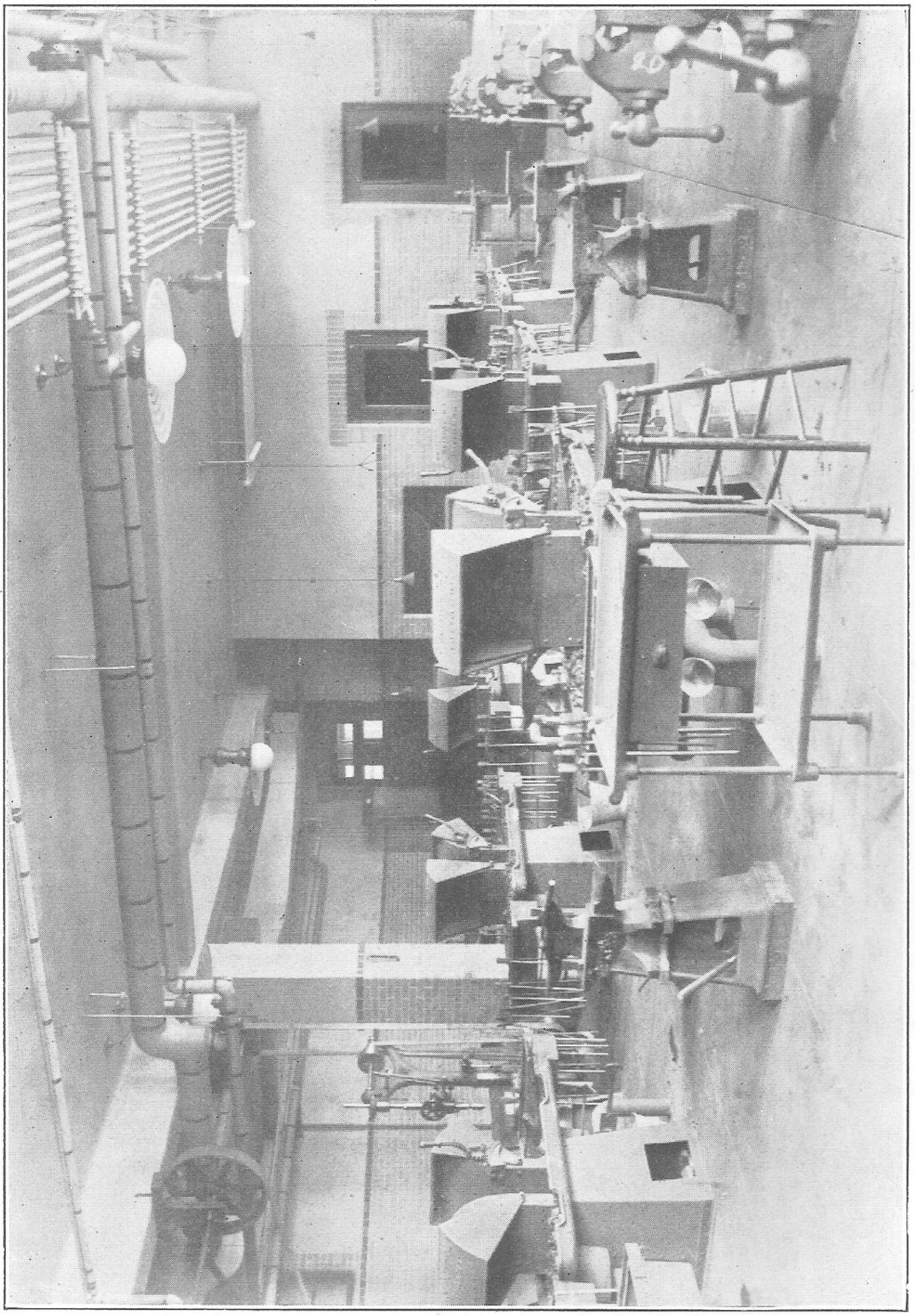
HIGHLAND PARK COLLEGE, DES MOINES, IOWA



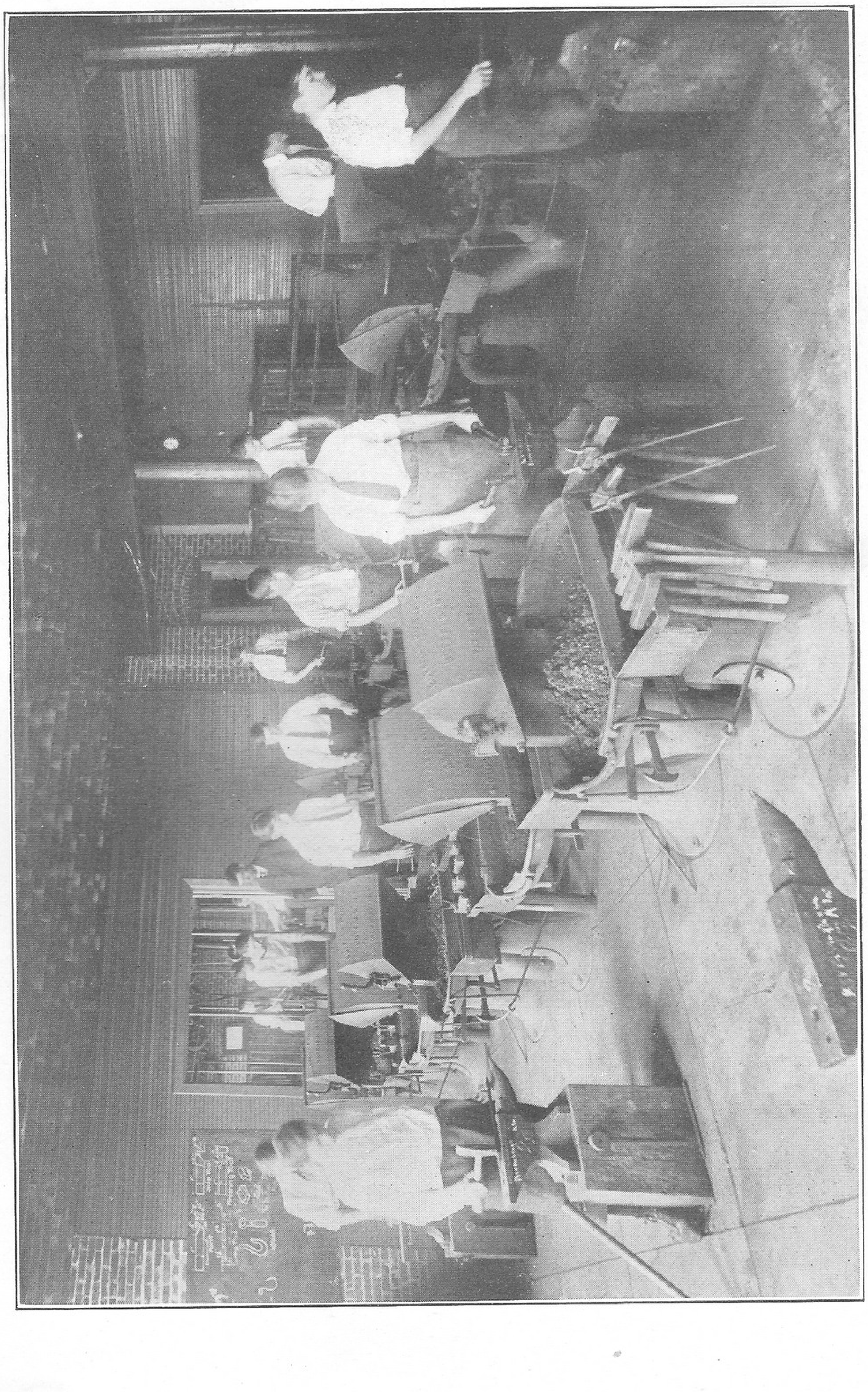
LOUISIANA UNIVERSITY, BATON ROUGE, LA.



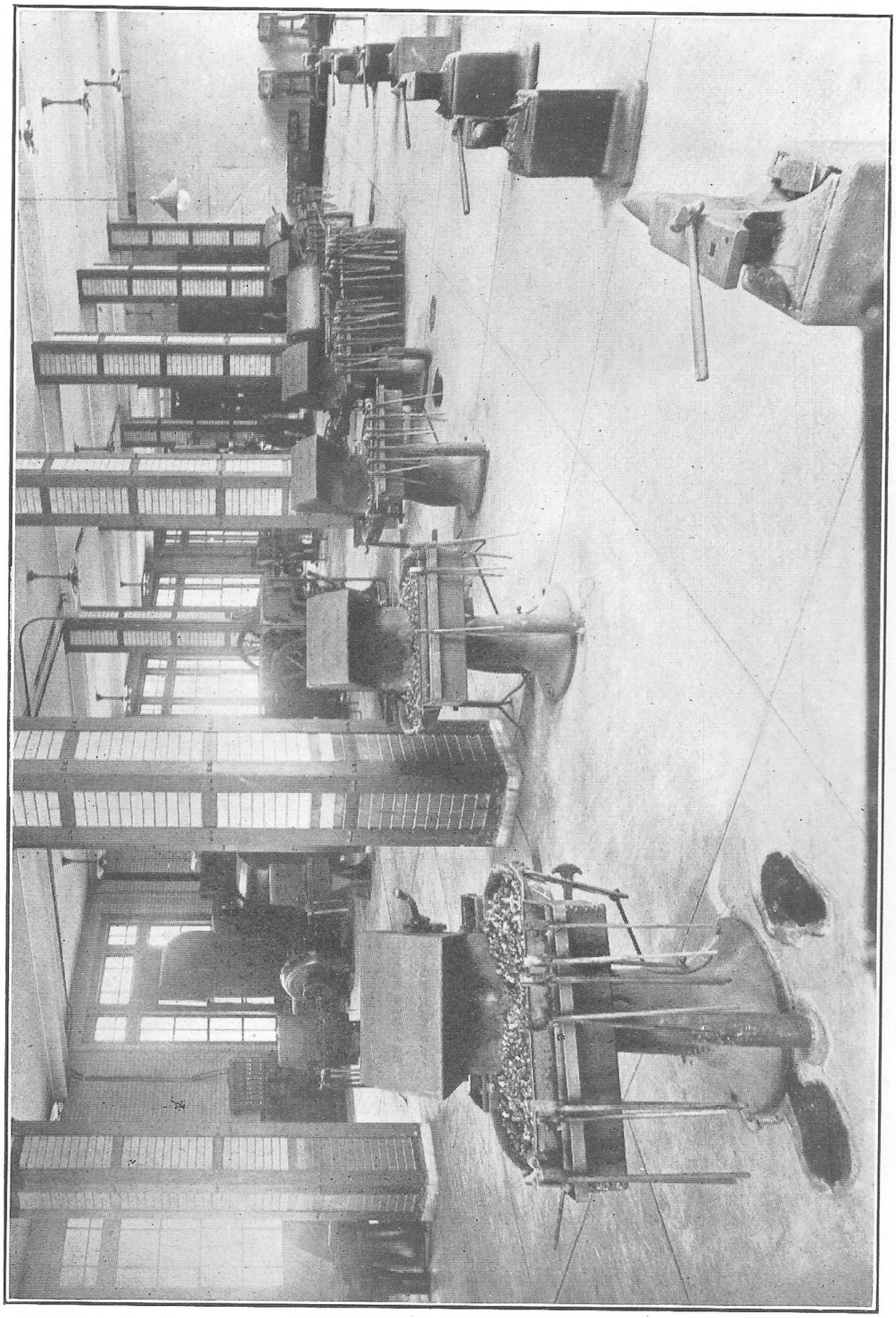
FORGE SHOP AND ENGINEERING ROOM, SWARTHMORE COLLEGE



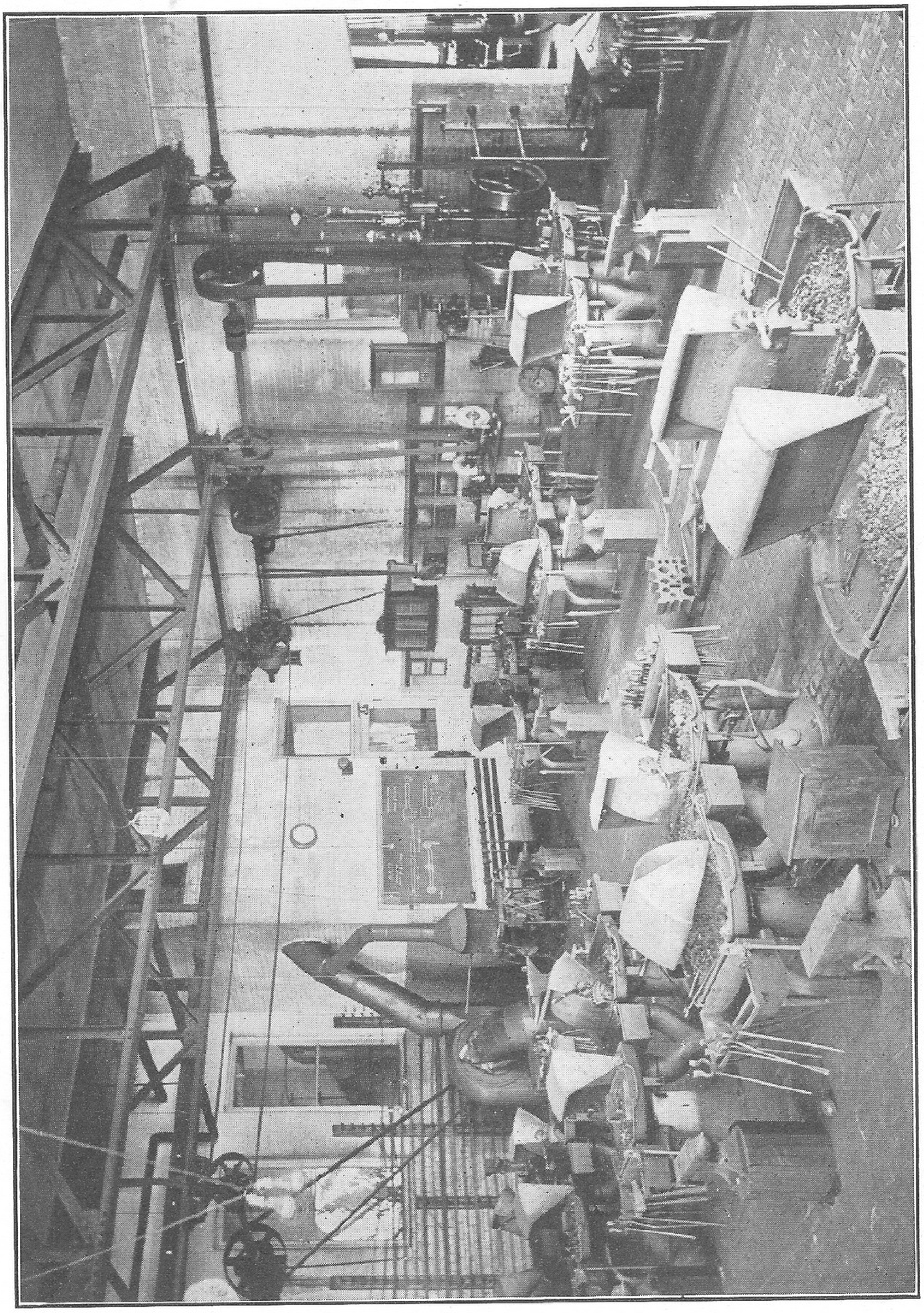
EAST SIDE HIGH SCHOOL, NEWARK, N. J.



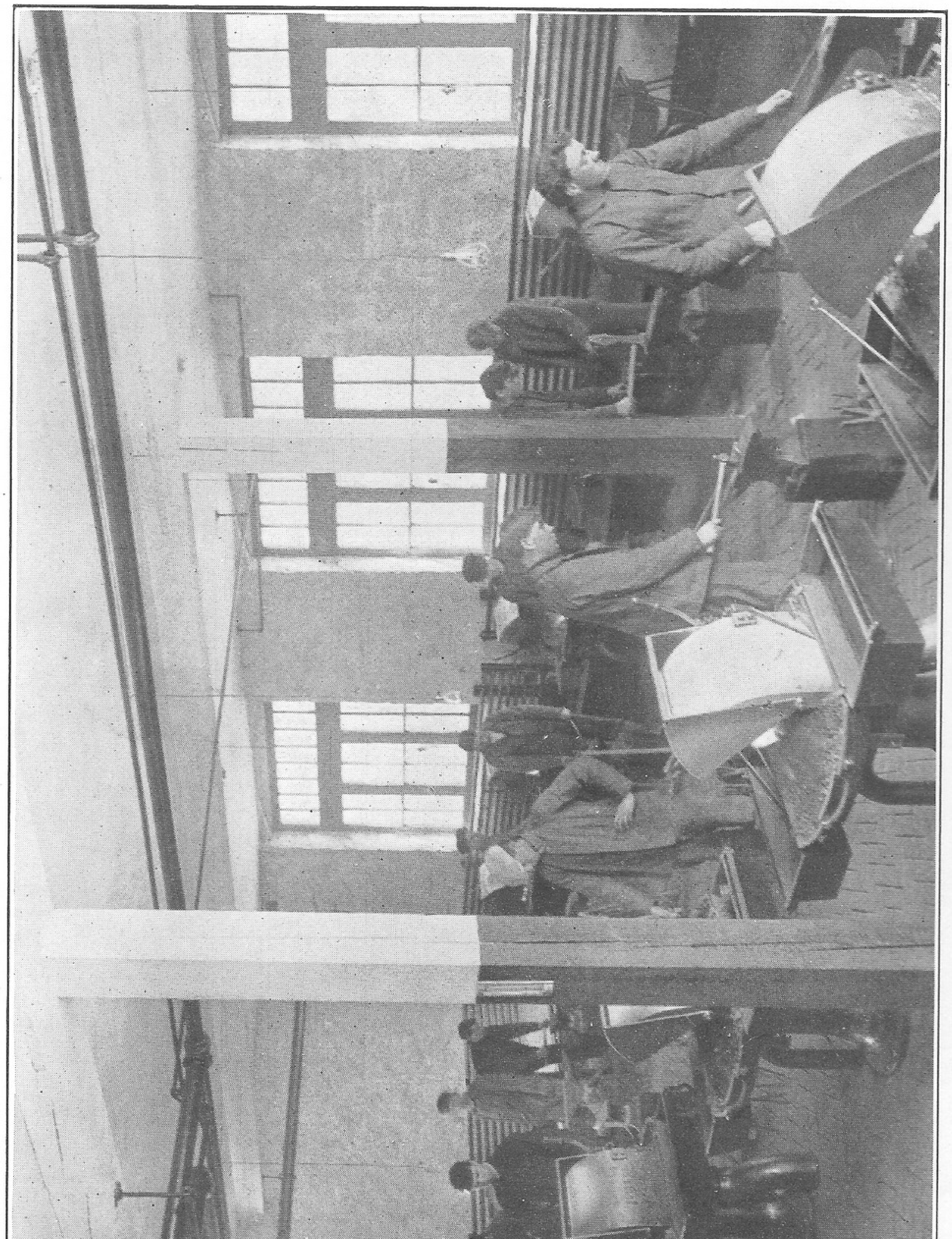
BIRMINGHAM HIGH SCHOOL, BIRMINGHAM, ALA.



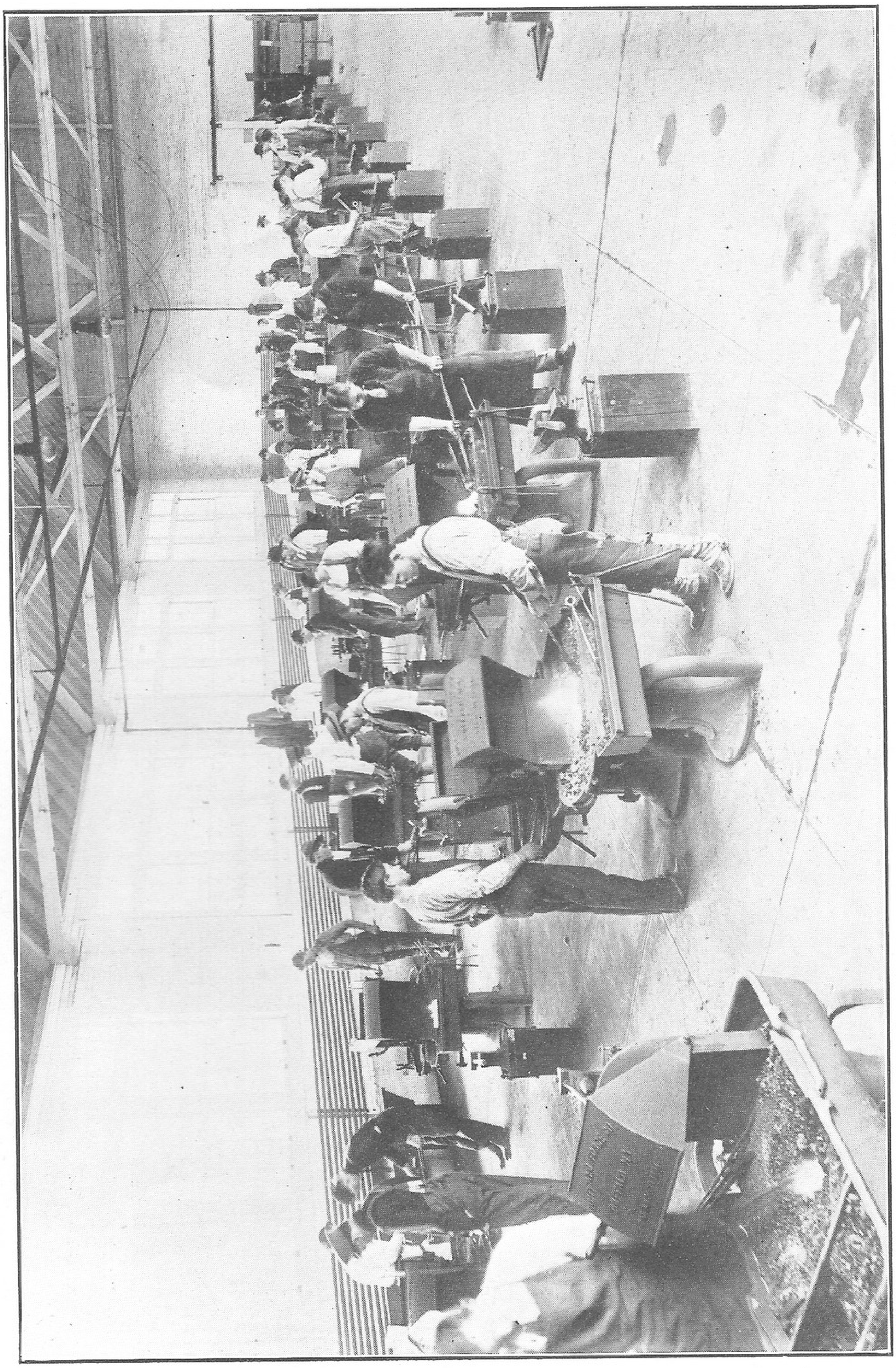
CARNEGIE TECHNICAL SCHOOLS, SCHENLEY PARK, PITTSBURGH



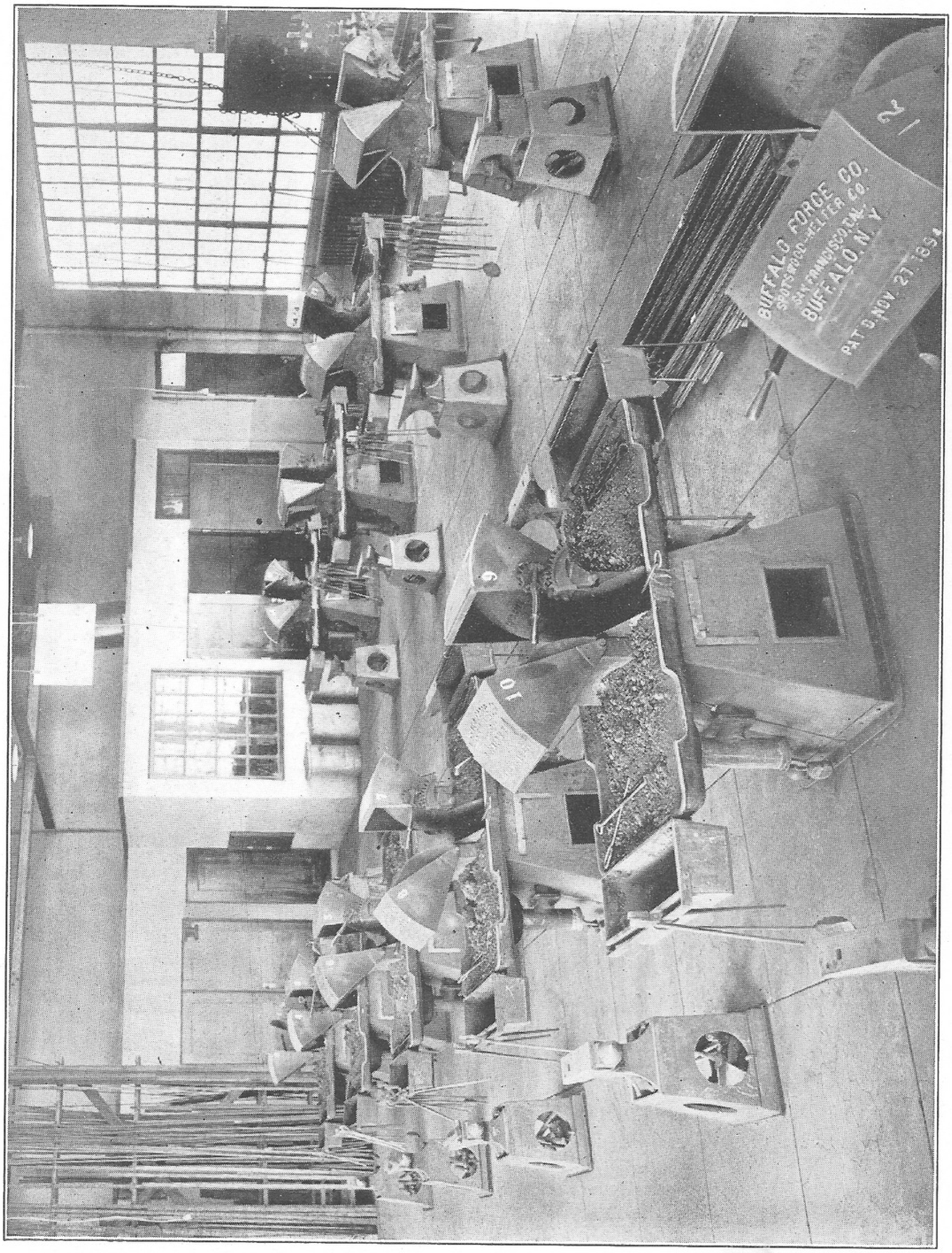
FORGE ROOM AT THE STOUT INSTITUTE, MENOMONIE, WISCONSIN



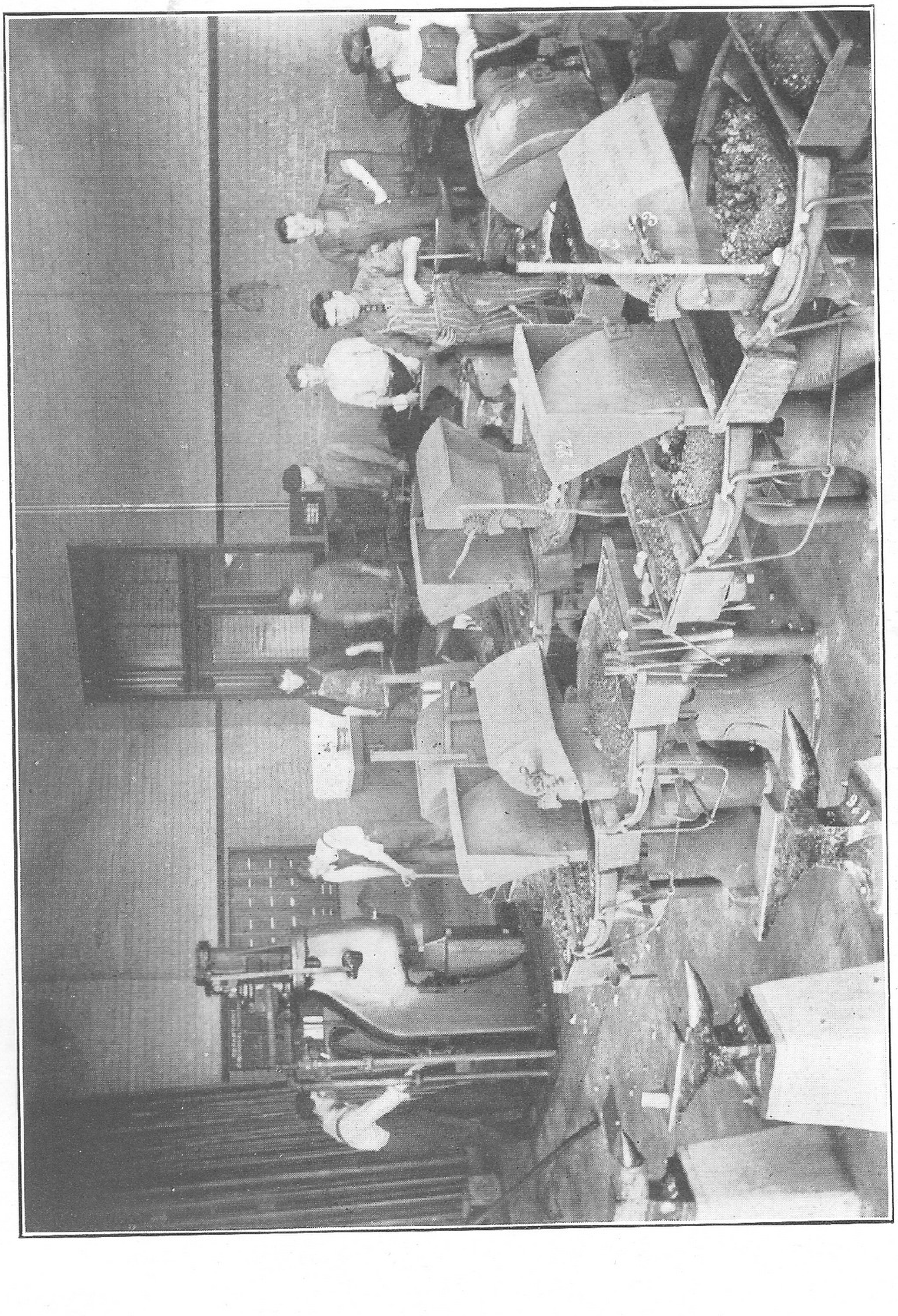
MANUAL TRAINING SCHOOL, ISHPEMING, MICHIGAN



OREGON AGRICULTURAL COLLEGE, CORVALLIS, OREGON

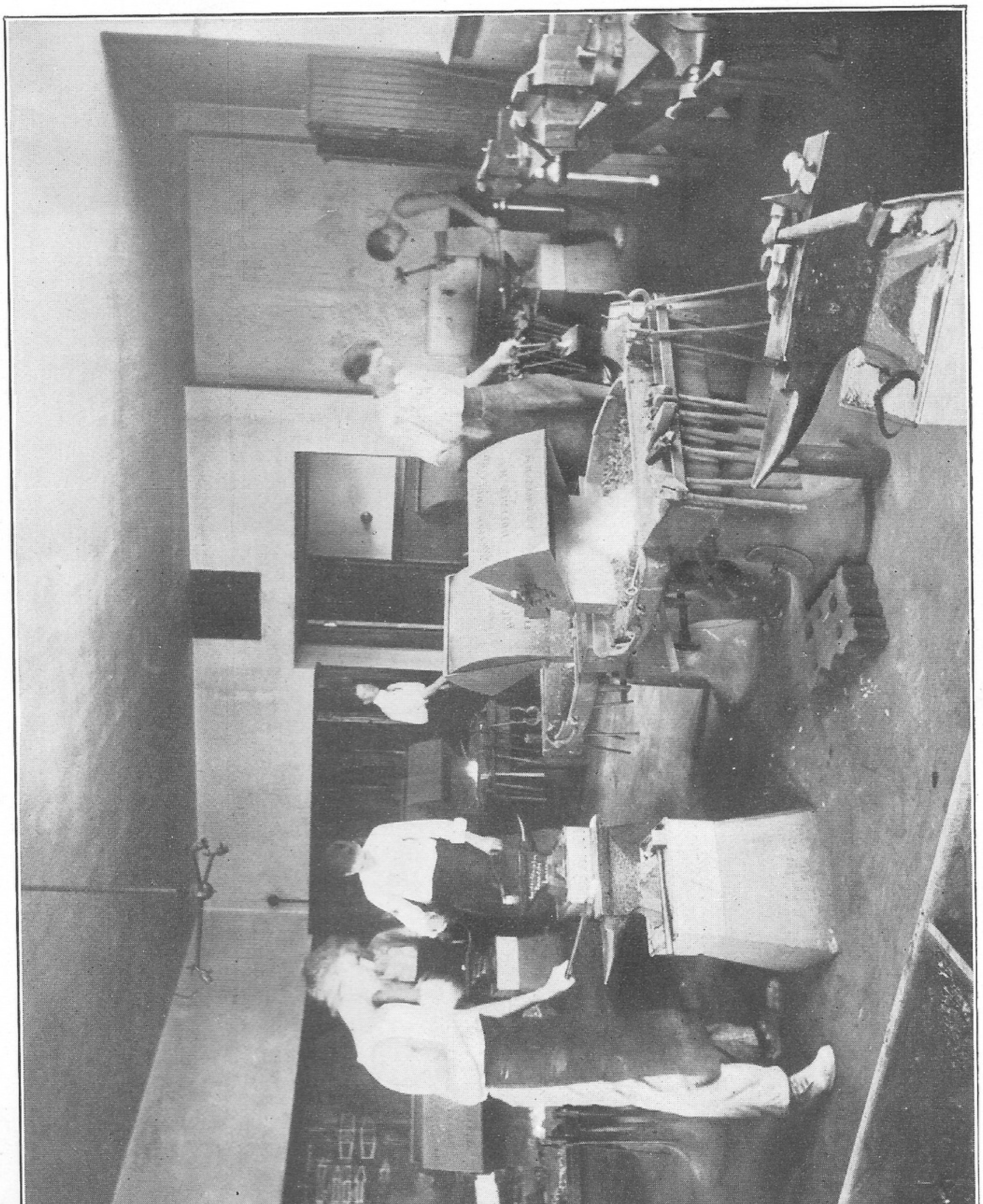


OAKLAND, CALIFORNIA TECHNICAL HIGH SCHOOL

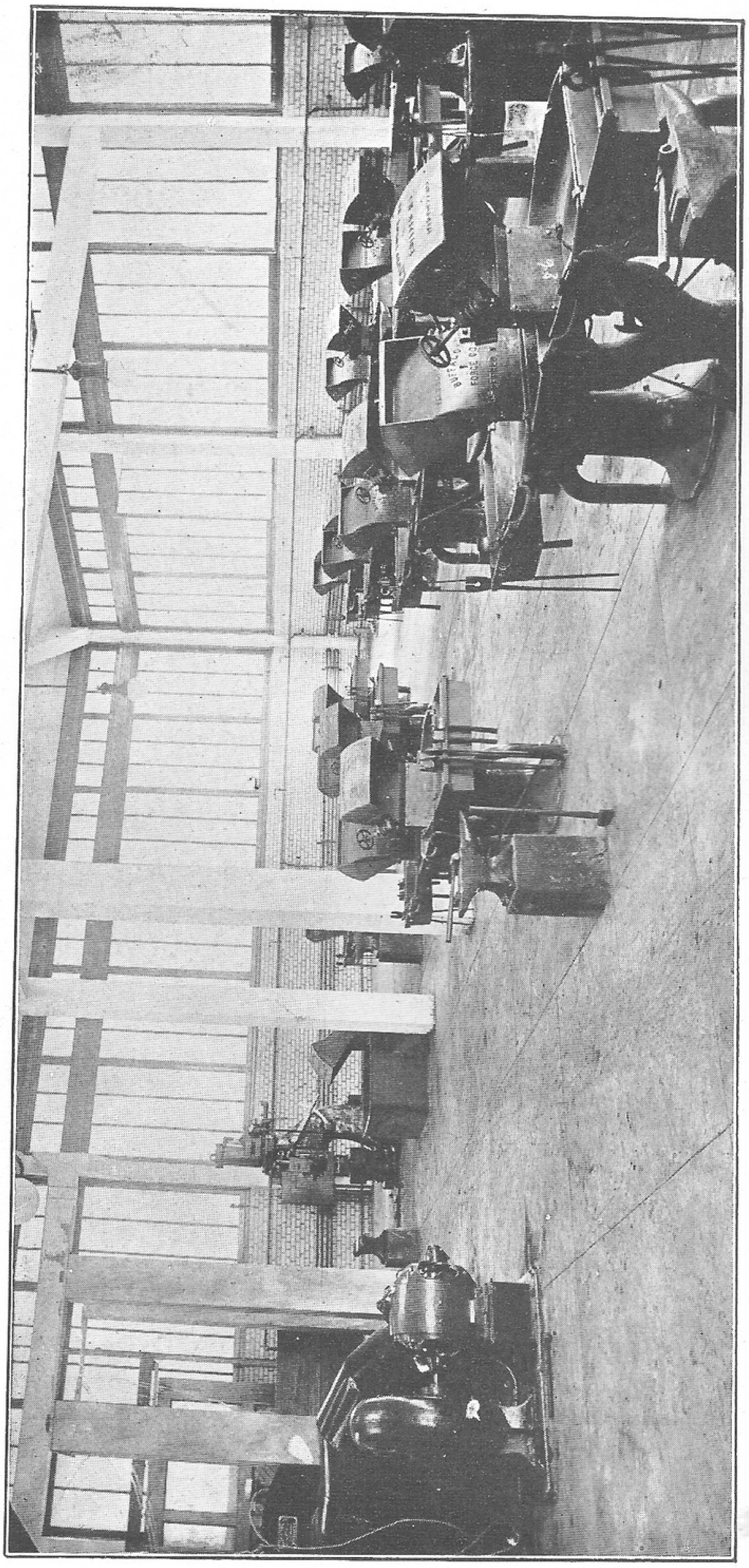


SECTION OF FORGE SHOP, UNIVERSITY OF NEBRASKA, LINCOLN, NEBR.

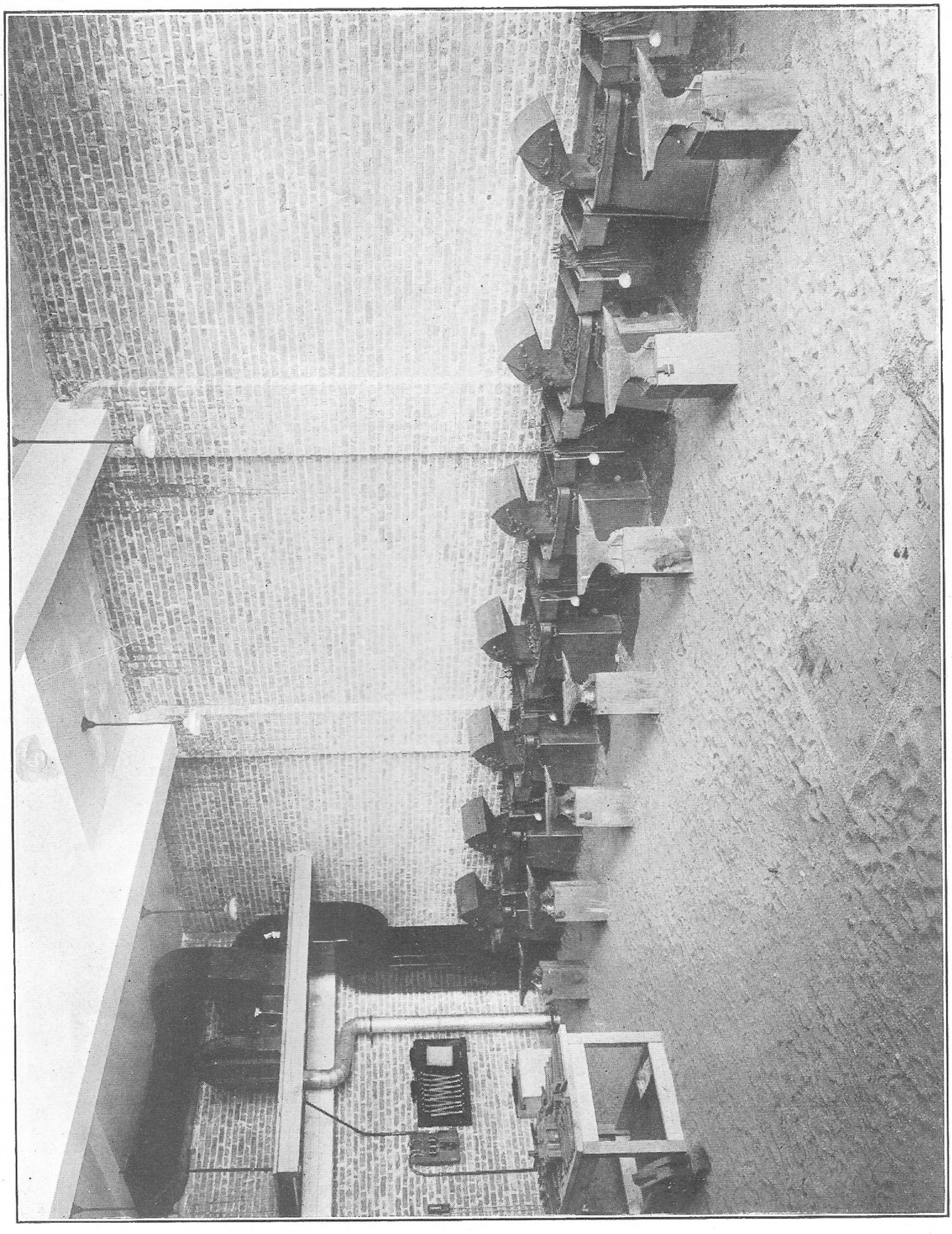
UNIVERSITY OF NEBRASKA, LINCOLN, NEBRASKA



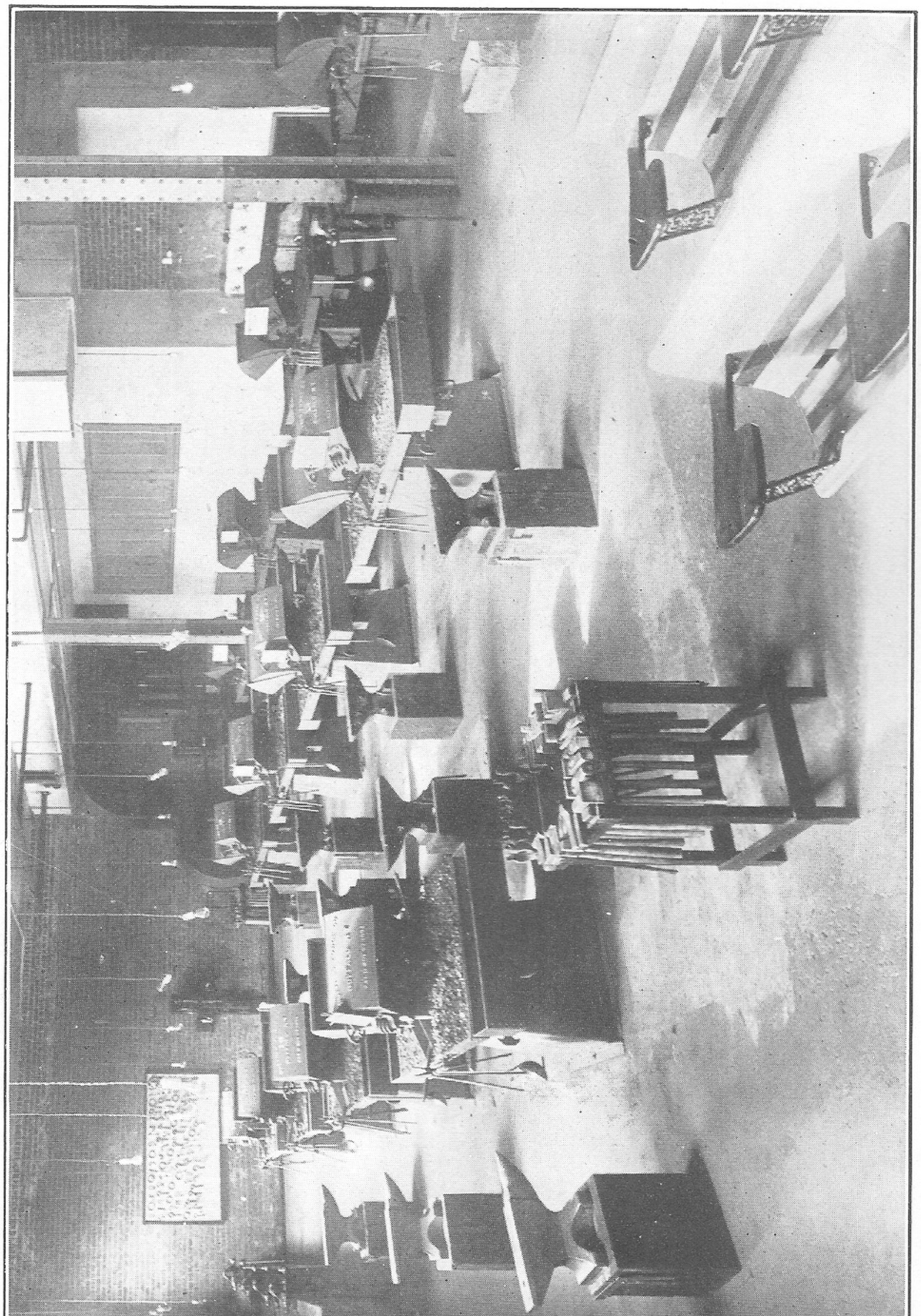
WESTPORT HIGH SCHOOL, KANSAS CITY, MO.



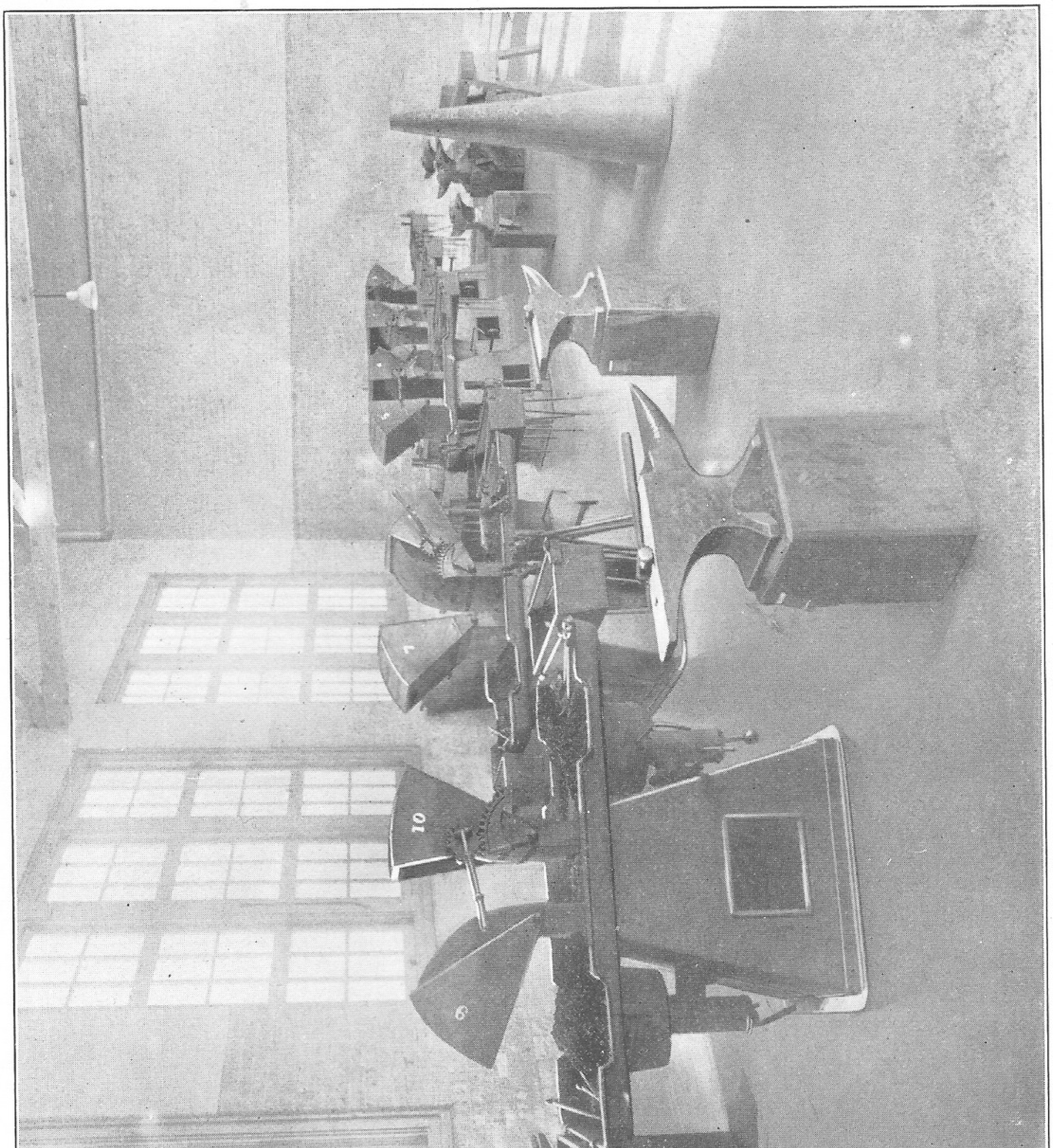
UNIVERSITY OF PORTO RICO, MAYAGUEZ, PORTO RICO



DEERFIELD-SHIELDS HIGH SCHOOL, HIGHLAND PARK, ILLINOIS

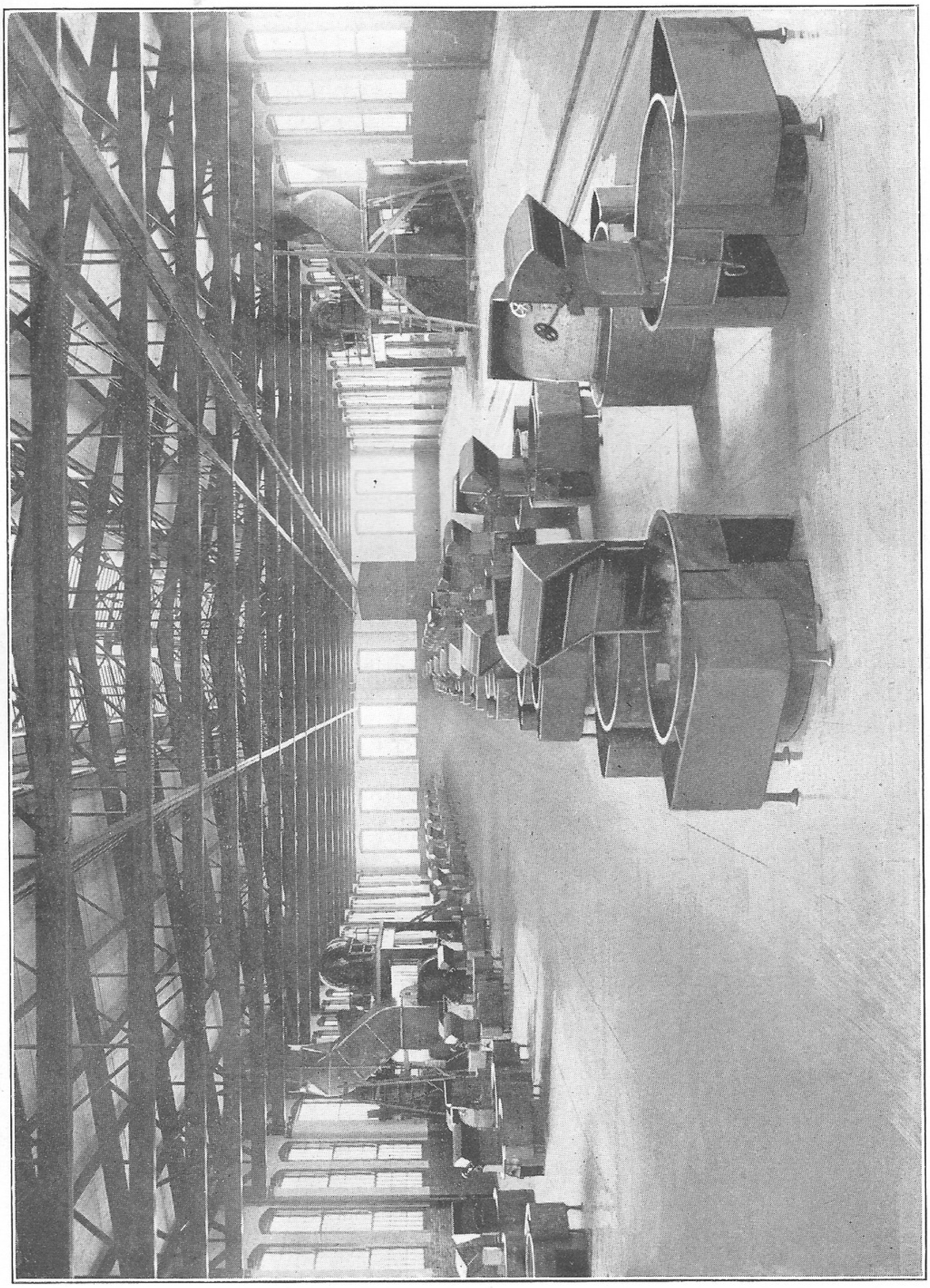


WESTERN HIGH SCHOOL, DETROIT, MICHIGAN



UNION HIGH SCHOOL, SACRAMENTO, CALIFORNIA

TECHNICAL HIGH SCHOOL, BUFFALO, N. Y.



LEHIGH VALLEY R. R. REPAIR SHOPS, SAYRE, PA.
100 large Buffalo Down-Draft Forges

Installations in Colleges and Technical Schools

Agricultural and Mechanical College, Greensboro, N. C.
Akron High School, Akron, Ohio.
Alabama Polytechnic Institute, Auburn, Ala.
Alhambra High School, Alhambra, Cal.
Allen Manual Training School, Austin, Texas.
Amsterdam Training School, Amsterdam, Holland.
Anaheim High School, Anaheim, Cal.
Arkansas Industrial University, Fayetteville, Ark.
Austin Public School, Austin, Texas.
Austin High School, Chicago, Ill.

Baltimore Polytechnic Institution, Baltimore, Md.
Barlow School of Industrial Arts, Binghamton, N. Y.
Barrett Manual Training School, Henderson, Ky.
Blees Military Academy, Macon, Mo.
Bowen High School, Chicago, Ill.
Boyle Heights High School, Los Angeles, Cal.
Bradley Polytechnic Institute, Peoria, Ill.
Brittania High School, Vançouver, B. C.
Bushwick High School, Brooklyn, N. Y.

California State Normal School, Los Angeles, Cal.
Camden Manual Training School, Camden, N. J.
Carnegie Technical School, Pittsburgh, Pa.
Carnegie Technical School, Schenley Park, Pa.
Cass High School, Detroit, Mich.
Central High School, (M. T. Annex) St. Louis, Mo.
Central High School, Muskogee, Okla.
Central Comm. and M. S. School, Newark, N. J.
Chisholm High School, Chisholm, Wis.
Clemson College, Clemson College, S. C.
Colorado State Agricultural College, Ft. Collins, Colo.
College of Hawaii, Honolulu, H. I.

Deerfield-Shields Township High School, Highland Park, Ill.
Denver Manual Training High School, Denver, Colo.
Detroit University School, Detroit, Mich.
Detroit Manual Training School, Detroit, Mich.
Drexel Institute, Philadelphia, Pa.

East Side High School, Milwaukee, Wis.
East St. Louis High School, East St. Louis, Ill.

Faribault High School, Faribault, Minn.
Fifth Ward Manual Training School, Alleghany, Pa.
Fifth Ave. High School, Pittsburgh, Pa.
Findlay Manual Training School, Findlay, Ohio.
Flathead County Free High School, Kalispell, Mont.
Ft. Dodge Public Schools, Ft. Dodge, Iowa.

Installations in Colleges and Technical Schools—Continued

Georgia School for the Deaf, Cave Springs, Ga.
Girard College, Philadelphia, Pa.
Glenwood Manual Training School, Glenwood, Ill.
Glendale High School, Glendale, Cal.
Grand Rapids High School, Grand Rapids, Mich.

Halsted High School, Halsted, Kansas.
Hampton Normal and Agricultural Institute, Hampton, Va.
Haskell Institute, Lawrence, Kansas.
Helena High School, Helena, Mont.
Highland Park College, Des Moines, Iowa.
House of Refuge, Randall's Island, N. Y.

Independent School District, Davenport, Ia.
Ishpeming Manual Training School, Ishpeming, Mich.

Kansas City Manual Training School, Kansas City, Mo.
Kelvine Technical School, Winnipeg, Manitoba, Can.
King Edward High School, Vancouver, B. C.

La Crosse High School, La Crosse, Wis.
Lafayette College, Easton, Pa.
Lincoln Park School, Tacoma, Wash.
Lincoln Institute, Jefferson City, Mo.
Lincoln School, Hibbing, Minn.
Long Beach Technical High School, Long Beach, Cal.
Louisiana Industrial Institute, Ruston, La.
Louisiana State University, Baton Rouge, La.

Manual Arts High School, Los Angeles, Cal.
Manual Training Department, School District No. 1, Trinidad, Colo.
Manual Training School, Dayton, Ohio.
Manual Training School, Honolulu, Hawaii.
Manual Training School, Kansas City, Mo.
Manual Training School, Amersfoort, Holland.
Manhattan School No. 100, New York, N. Y.
Miller Manual Labor School of Albemarle, Crozet, Va.
Milwaukee Manual Training School, Milwaukee, Wis.
Minnesota State Training School, Red Wing, Minn.
Montana State College of Agriculture and Mechanic Arts, Bozeman, Mont.
Municipal School of Technology, Manchester, England.

New Mexico College of Agriculture and Mechanic Arts, Los Cruces, New Mexico.
New York University, University Heights, N. Y.
New York State Reformatory, Elmira, N. Y.
Ninth Ward Manual Training School, Alleghany, Pa.
North Dakota Agricultural College, Fargo, N. D.
North East High School, Kansas City, Mo.

Oakland Technical High School, Oakland, Cal.
Oklahoma Agricultural and Mechanical College, Stillwater, Okla.

Installations in Colleges and Technical Schools—Continued

Oklahoma School of Industrial Arts, Langston, Okla.
Oklahoma School of Mines, Wilburton, Okla.
Old Soldiers and Sailors Orphans' Home, Xenia, Ohio.
Orange Union High School, Orange, Cal.

Pennsylvania State Reform School, Morganza, Pa.
Pennsylvania Training School, Morganza, Pa.
Pennsylvania Industrial Reformatory, Huntington, Pa.
Philadelphia Central High School, Philadelphia, Pa.
Pittsburgh High School, Pittsburgh, Pa.
Portland Trade School, Portland, Ore.
Polytechnic Union High School, Venice, Cal.
Prairie View State Normal School, Prairie View, Texas.

Red Wing Manual Training School, Red Wing, Minn.
Robert College, Constantinople, Turkey.
Rochester Athenaenum and Mechanics Institute, Rochester, N. Y.
Rockford School, Rockford, Ill.

Sacramento High School, Sacramento, Cal.
Sam Houston Normal Institute, Huntsville, Texas.
Schenley School, Pittsburgh, Pa.
Seldon High School, St. Louis, Mo.
Shaw University, Raleigh, N. C.
Soldiers Orphans' Home Manual Training School, Normal, Ill.
South Bend Manual Training School, South Bend, Ind.
South High School, Grand Rapids, Mich.
Springfield High School, Springfield, Ohio.
Stout Manual Training School, Menomonie, Wis.
St. Johns Technical School, Winnipeg, Canada.
Stuyvesant High School, New York, N. Y.

Tacoma School, Tacoma, Wash.
Technical High School, Buffalo, N. Y.
Tempe Normal School, Tempe, Ariz.
Texas State Agricultural and Mechanical College, College Station, Texas.
Tokio Koggo Gakko Institute, Asakusa, Tokio, Japan.

University of California, Sacramento, Cal.
University of Colorado, Boulder, Colo.
University of Illinois, Champaign, Ill.
University of Kentucky, Lexington, Ky.
University of Missouri, Columbia, Mo.
University of Nebraska, Lincoln, Neb.
University of Montana, Missoula, Mont.
University of Texas, Austin, Texas.
Union Training School, Red Wing, Minn.
University of South Dakota, Vermillion, So. Dak.
University of North Dakota, Grand Forks, N. D.
University of W. Va., Morganstown, W. Va.
University of Wisconsin, Madison, Wis.

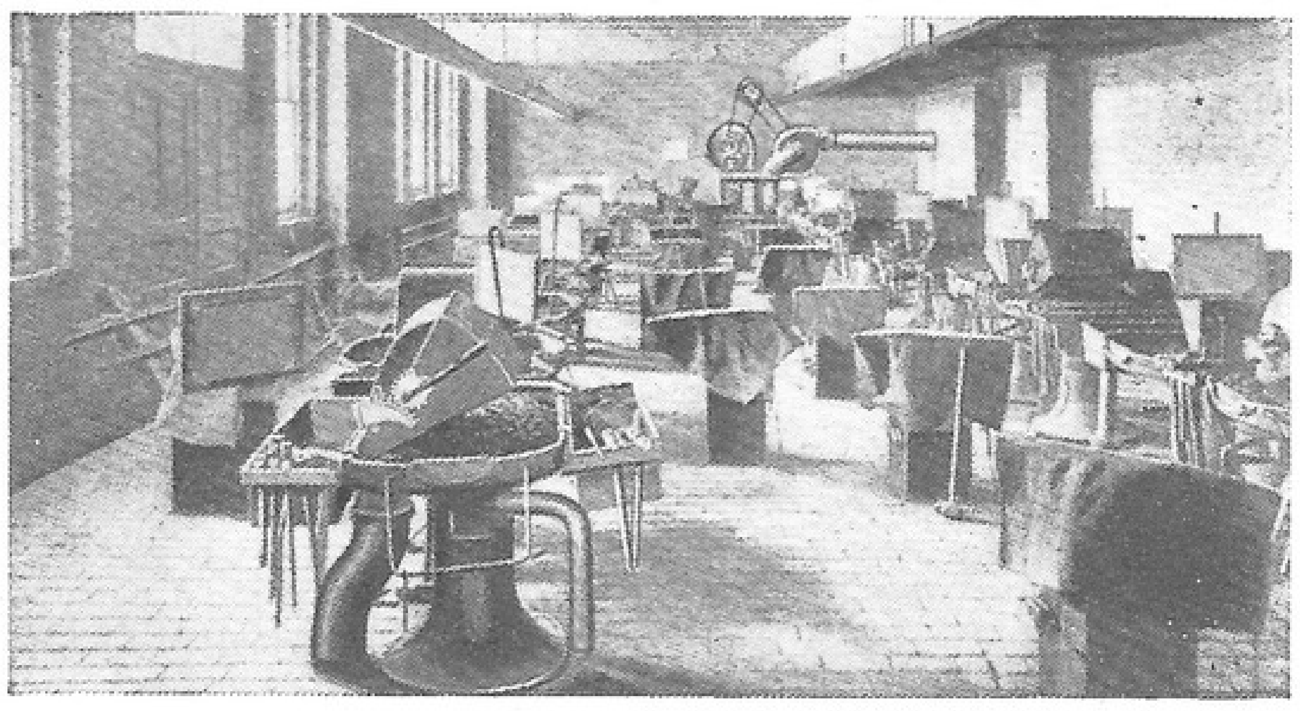
Installations in Colleges and Technical Schools—Continued

University of Wyoming, Laramie, Wyo.
University of Porto Rico, Mayaguez, Porto Rico.
U. S. Indian Training School, Payallup, Cal.
Utah Agricultural College, Lund, Utah.

Vocational High School, Syracuse, N. Y.

Washington (Colored) Manual Training School, Washington, D. C.
Washington (White) Manual Training School, Washington, D. C.
Washington University, St. Louis, Mo.
Walsh Co. Agricultural and Training School, Park River, N. D.
Wentworth Institute, Boston, Mass.
West Chester School, West Chester, Pa.
Westerly, R. I. Public School Department, Westerly, R. I.
Westport High School, Kansas City, Mo.
Wilmington High School, Wilmington, Del.
Wilberforce University, Wilberforce, Ohio.
Wisconsin Industrial School for Boys, Waukesha, Wis.
Wisconsin School for the Deaf, Delavan, Wis.
Wisova Colored Institute, Institute, W. Va.

Young Men's Christian Association, Dayton, Ohio.



SIES-CO., BUFFALO 10M-1916